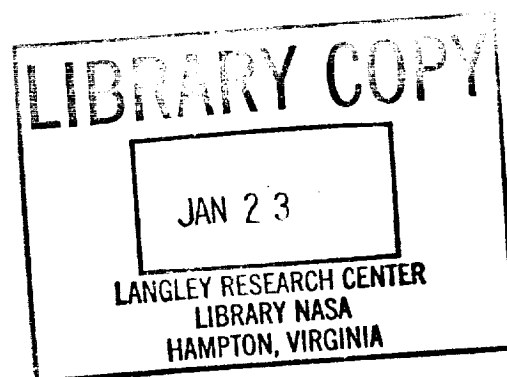
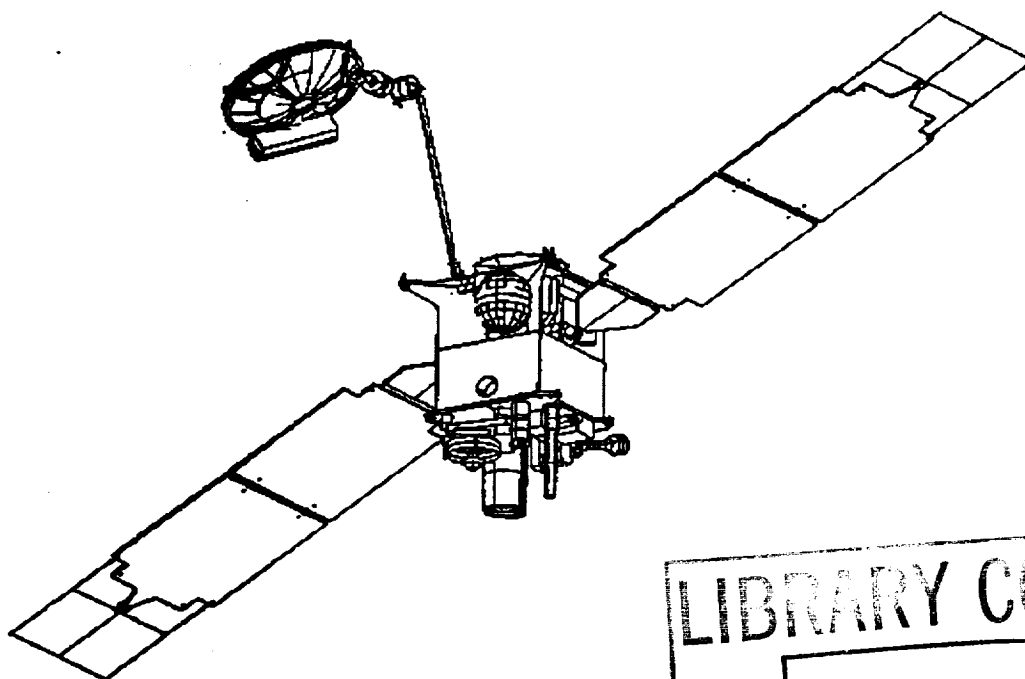




National Aeronautics and
Space Administration

Mars Global Surveyor Mission Environmental Assessment

IN-11-5R



September 1995

Prepared for and in cooperation with:

National Aeronautics and Space Administration
Office of Space Science
Solar System Exploration Division
Washington, DC 20546-0001

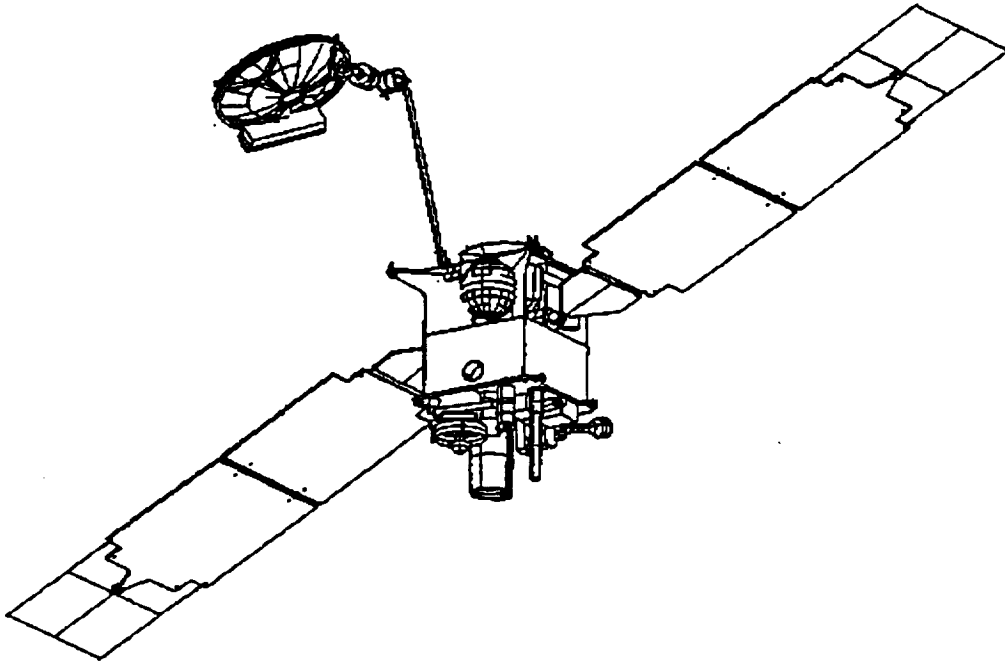


Jet Propulsion Laboratory
California Institute of Technology
JPL D-12506



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TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS	x
EXECUTIVE SUMMARY	ES-1
1 PURPOSE AND NEED.....	1-1
1.1 PURPOSE OF THE PROPOSED ACTION	1-1
1.2 NEED FOR THE PROPOSED ACTION	1-2
2 PROPOSED ACTION AND ALTERNATIVES	2-1
2.1 PROPOSED ACTION	2-1
2.1.1 Mars Global Surveyor (MGS) Mission Description	2-1
2.1.2 MGS Science Objectives	2-3
2.1.2.1 Characterize Surface Morphology at High Spatial Resolution to Quantify Surface Characteristics and Geological Processes	2-3
2.1.2.2 Determine the Composition and Map the Distribution of Surface Minerals, Rocks, and Ices; Measure the Surface Thermophysical Properties	2-4
2.1.2.3 Map the Global Topography, Geodetic Figure (Global Size and Shape) and Establish the Nature of the Gravitational Field of Mars	2-4
2.1.2.4 Establish the Existence of, and Investigate the Nature of, the Magnetic Field; Map the Crustal Remnant Field.....	2-4
2.1.2.5 Monitor Global Weather and Thermal Structure of the Atmosphere	2-4
2.1.2.6 Study Surface-Atmosphere Interaction by Monitoring Surface Features, Polar Caps, Polar Thermal Balance, Atmospheric Dust, and Condensate Clouds Over a Seasonal Cycle	2-5
2.1.3 Spacecraft Description	2-5
2.1.3.1 General	2-5
2.1.3.2 Spacecraft Pyrotechnic Devices	2-5

2.1.3.3	Science and Engineering Instrumentation	2-5
2.1.3.3.1	Magnetometer/Electron Reflectometer	2-5
2.1.3.3.2	Mars Orbiter Camera	2-6
2.1.3.3.3	Mars Orbiter Laser Altimeter	2-6
2.1.3.3.4	Thermal Emission Spectrometer	2-6
2.1.3.3.5	Radio Science Investigation.....	2-6
2.1.3.3.6	Mars Relay.....	2-8
2.1.4	Launch Vehicle	2-9
2.1.4.1	Payload Fairing	2-9
2.1.4.2	Delta II First and Second Stage	2-11
2.1.4.3	PAM-D Upper Stage	2-11
2.1.4.4	Flight Termination System	2-12
2.1.4.5	Launch Vehicle Debris	2-12
2.1.5	Cape Canaveral Air Station Operations	2-13
2.1.5.1	Launch Vehicle Processing	2-13
2.1.5.2	Spacecraft Processing	2-14
2.1.5.2.1	Planetary Protection Requirements.....	2-14
2.1.5.2.2	Spacecraft Component Assembly and Test Operations.....	2-14
2.1.5.2.3	Pad Activities.....	2-16
2.2	ALTERNATIVES TO THE PROPOSED ACTION	2-16
2.2.1	Alternative Launch Systems	2-16
2.2.1.1	Selection Criteria	2-16
2.2.1.2	Foreign Launch Systems	2-17
2.2.1.3	U.S. Launch Systems	2-17
2.2.1.3.1	Space Transportation System (STS)	2-17
2.2.1.3.2	U.S. Expendable Launch Systems.....	2-17
2.2.1.4	Summary	2-18
2.2.2	No-Action Alternative	2-18
3	GENERAL ENVIRONMENTAL CHARACTERISTICS OF CAPE CANAVERAL AIR STATION AND SURROUNDING AREA	3-1
3.1	REGIONAL AND LOCAL ENVIRONMENT	3-1
3.1.1	Population Distribution	3-1
3.1.2	Land Use	3-3
3.1.3	Economic Base	3-6
3.1.4	Public Facilities and Emergency Services	3-6
3.1.5	CCAS Facilities and Services	3-7
3.1.6	Archeological and Cultural Resources	3-8

3.2	NATURAL ENVIRONMENT	3-9
3.2.1	Meteorology and Air Quality	3-9
3.2.1.1	Meteorology	3-9
3.2.1.1	Air Quality	3-11
3.2.2	Noise	3-11
3.2.3	Land Resources	3-13
3.2.3.1	Geology	3-13
3.2.3.2	Soils	3-13
3.2.4	Hydrology and Water Quality	3-14
3.2.4.1	Surface Waters	3-14
3.2.4.2	Surface Water Quality	3-14
3.2.4.3	Ground Waters	3-15
3.2.4.4	Ground Water Quality	3-16
3.2.5	Biotic Resources	3-17
3.2.5.1	Terrestrial Biota	3-17
3.2.5.2	Aquatic Biota	3-18
3.2.5.3	Threatened and Endangered Species	3-19
4	ENVIRONMENTAL IMPACTS OF PROPOSED ACTION AND ALTERNATIVES	4-1
4.1	ENVIRONMENTAL IMPACTS OF A NORMAL LAUNCH	4-1
4.1.1	Air Quality	4-1
4.1.1.1	Emissions	4-1
4.1.1.2	Impacts.....	4-3
4.1.2	Land Resources	4-7
4.1.3	Local Hydrology and Water Quality	4-7
4.1.4	Ocean Environment	4-8
4.1.5	Biotic Resources	4-8
4.1.6	Threatened and Endangered Species	4-8
4.1.7	Developed Environment	4-8
4.1.7.1	Population and Socioeconomics.....	4-8
4.1.7.2	Safety and Noise Pollution.....	4-9
4.1.7.3	Cultural Resources.....	4-9
4.2	ACCIDENTS AND LAUNCH FAILURES	4-9
4.2.1	Liquid Propellant Spill	4-9
4.2.2	Launch Failures	4-10
4.3	ENVIRONMENTAL IMPACTS OF ALTERNATIVES	4-10
5	REGULATORY REVIEW	5-1
5.1	AIR QUALITY	5-1
5.2	WATER QUALITY	5-1

5.2.1	Stormwater Discharge	5-1
5.2.2	Sanitary and Industrial Wastewater Discharge	5-1
5.2.3	Floodplains and Wetlands	5-2
5.3	HAZARDOUS WASTES	5-2
5.4	SPILL PREVENTION	5-2
5.5	COASTAL MANAGEMENT PROGRAM	5-2
5.6	CULTURAL RESOURCES	5-3
5.7	CORRESPONDENCE WITH FEDERAL AGENCIES	5-3
5.7.1	United States Environmental Protection Agency	5-3
5.8	CORRESPONDENCE WITH STATE AGENCIES	5-3
5.8.1	Florida State Clearinghouse.....	5-3
6	REFERENCES	6-1

APPENDICES

A	CORRESPONDENCE WITH STATE AND FEDERAL AGENCIES.....	A-1
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FIGURES

2-1	MGS Earth-Mars Trajectory	2-2
2-2	MGS Mapping Configuration	2-3
2-3	MGS Launch Configuration Inside the Delta II 7925 Payload Fairing	2-9
2-4	Delta II 7925 Launch Configuration	2-10
2-5	Payload Assist Module-Delta (PAM-D) Upper Stage	2-11
2-6	Launch Vehicle and Spacecraft Processing Areas, KSC/CCAS	2-15
3-1	Regional Area of Interest	3-2
3-2	Location of CCAS Relative to the Region of Interest	3-4
3-3	Land Use at CCAS	3-5
3-4	Launch Complex 17 (LC-17)	3-7
3-5	Wind Roses Indicating Seasonal Wind Directions — Lower Atmospheric Conditions: Cape Canaveral/Merritt Island Land Mass	3-10
4-1	Delta II 7925 Launch Area Flight Profile	4-4
4-2a	Delta II 7925 Boost Profile for MGS	4-5
4-2b	Delta II Injection Profile for MGS	4-5

TABLES

2-1	Mars Global Surveyor Instruments and Science Objectives	2-8
3-1	State and Federal Air Quality Standards	3-12
3-2	Launch Noise Levels at Kennedy Space Center	3-13
3-3	Summary of Water Quality Monitoring Data for South Banana River	3-15
3-4	Ground Water Quality for the Floridan Aquifer at CCAS	3-16
3-5	Listed and Proposed Threatened and Endangered Animal Species and Candidate Animal Species in Brevard County and Their Status On CCAS	3-20
4-1	Combustion Products for the GEM Solid Rocket	4-2
4-2	Exhaust Products for the Delta II First Stage (Modified RS-27A)	4-2
4-3	Combustion Products for Delta II 7925 GEM Failure Scenario	4-11
4-4	Combustion Products for Delta II 7925 Catastrophic Failure Scenario	4-11

ACRONYMS AND ABBREVIATIONS

Al ₂ O ₃	Aluminum Oxide
C	Celsius temperature scale
C ₃	Injection Energy
CCAS, CCAFS	Cape Canaveral Air (Force) Station
CCD	Charge Coupled Device
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cm	centimeters = .01 meter
CNES	French Space Agency
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
DMCO	Delta Mission Check-Out
DSN	Deep Space Network
EA	Environmental Assessment
EOD	Explosive Ordnance Disposal
ER	Eastern Range
ESA	European Space Agency
F	Fahrenheit temperature scale
FCREPA	Florida Commission on Rare and Endangered Plants and Animals
FDEP	Florida Department of Environmental Protection
FGFWFC	Florida Game and Fresh Water Fish Commission
fps	feet per second
ft	feet
FTS	Flight Termination System
FWS	U.S. Fish and Wildlife Service
GaAs	Gallium-Arsenide
GEM	Graphite Epoxy Motor
HCl	Hydrogen Chloride
HGA	High Gain Antenna
HTPB	Hydroxyl-Terminated PolyButediene
IELV	Intermediate Expendable Launch Vehicle
in	inch(es)
JPL	Jet Propulsion Laboratory
KSC	Kennedy Space Center
kg	kilogram = 2.2 pounds
km	kilometer = 1×10^3 meters = 1,000 meters = 0.62 mile
km/s	kilometers per second
LBS	Launch Base Support
LC-17	Launch Complex 17, CCAS
LEO	Low Earth Orbit
LGA	Low Gain Antenna

m	meter(s) = 39.37 in
MAC	Maximum Allowable Concentration
MAG/ER	Magnetometer/Electron Reflectometer
MGS	Mars Global Surveyor
MHz	Megahertz (1×10^6 cycles/second = 1 million cycles per second)
mi	mile(s)
mJ	milliJoule (.001 Joule), unit of energy
MLV	Medium Launch Vehicle
MOC	Mars Orbiter Camera
MOI	Mars Orbit Insertion
MOLA	Mars Orbiter Laser Altimeter
MR	Mars Relay
mph	miles per hour
m/s	meters per second
MSPSP	Missile System Pre-Launch Safety Plan
$\mu\text{g}/\text{m}^3$	micrograms per cubic meter (.000001 gram/meter ³)
μm	micron (or micrometer) = 1×10^{-6} meter = .000001 meter = 3.937×10^{-5} in
N	Newton = 1 kg m/s^2
N ₂ H ₄	Hydrazine
N ₂ O ₄	Nitrogen Tetroxide
NAAQS	National Ambient Air Quality Standard
NaOH	Sodium Hydroxide
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NCS	Nutation Control System
Nd-YAG	Neodmium (doped) - Yttrium Aluminum Garnet
NEPA	National Environmental Policy Act
NHL	National Historic Landmark
NO _x	Nitrogen Oxides (generic)
NSI	NASA Standard Initiator
NTO	Nitrogen Tetroxide
OFW	Outstanding Florida Water
OSHA	Occupational Health and Safety Administration
PAFB	Patrick Air Force Base
PAM-D	Payload Assist Module-Delta
PEL	Permissible Exposure Level
pH	level of acidity or alkalinity relative to water
PHSF	Payload Hazardous Servicing Facility
PLF	Payload Fairing
ppm	parts per million
ppt	parts per thousand
PSP	Project Safety Plan
RCRA	Resource Conservation and Recovery Act

REEDM	Rocket Effluent Exhaust Dispersion Model
RF	Radio Frequency
RP-1	thermally stable kerosene fuel
RS	Radio Science
S&A	Safe & Arm
SCS	Soil Conservation Service (of the U.S. Department of Agriculture)
Si	Silicon
SNC	Shergotty, Nakhla, and Chassigny (Meteorites)
SPCCP	Spills Prevention, Control, and Countermeasures Plan
SRM	Solid Rocket Motor
SRMU	Solid Rocket Motor Upgrade
SRP	Safety Review Panel
SSE	Solar System Exploration
STS	Space Transportation System (Space Shuttle)
TBD	To be determined
TBR	To be revised
TCM	Trajectory Correction Manuever
TEL	Telecommunications Subsystem
TES	Thermal Emission Spectrometer
TMU	Telemetry Modulation Unit
UHF	Ultra High Frequency
USAF	United States Air Force
U.S.C.	United States Code
USO	Ultra-Stable Oscillator
WWTP	Wastewater Treatment Plant

EXECUTIVE SUMMARY

PROPOSED ACTION

This environmental assessment addresses the proposed action to complete the integration and launch the Mars Global Surveyor (MGS) spacecraft from Cape Canaveral Air Station (CCAS), Florida, during the launch window in November 1996. The spacecraft would be assembled and tested at Lockheed-Martin and shipped to Kennedy Space Center (KSC) for checkout and propellant loading. The Transfer Orbit stage would be assembled and integrated with the spacecraft at KSC. The integrated spacecraft and Transfer Orbit stage would then be transferred to Launch Complex 17 (LC-17) on Cape Canaveral Air Station.

The baseline launch vehicle, a Delta II 7925, would be assembled in facilities at CCAS before being transferred to LC-17. The Delta II 7925 consists of a liquid bipropellant main engine, a liquid bipropellant second stage engine, and nine graphite epoxy motor (GEM) strap-on solid rockets. While most of the check-out of the spacecraft and launch vehicle would be performed at individual integration buildings, operations completed at the launch site would include mating of the spacecraft and upper stage with the launch vehicle, integrated systems test and check-out, launch vehicle liquid propellant servicing, and ordnance installation.

PURPOSE AND NEED FOR THE ACTION

Mars Global Surveyor is part of the Solar System Exploration Program to the inner planets designed to maintain a sufficient level of scientific investigation and accomplishment so that the United States retains a leading position in solar system exploration through the end of the century. The Program consists of a specific sequence of missions, based on technological readiness, launch opportunities, rapidity of data return, and a balance of scientific disciplines. The purpose of the MGS mission would be to deliver a spacecraft platform to a low-altitude polar orbit around Mars where it would collect global observations of basic geological, geophysical, and climatological processes of the planet. To satisfy this purpose, the MGS mission would support a scientific set of objectives.

Although significant insights into the evolution of Mars have resulted from previous explorations, large gaps in knowledge remain. Detailed global maps of surface topography, the distribution of minerals, the planet's mass, size, and shape, the characterization of Mars' gravitational and magnetic fields, and the monitoring of global weather, collected over the period of one Martian year (about two Earth years), would help answer some of the questions about the evolution of Mars. Such an investigation would help scientists better understand the current state of water on Mars, the evolution of the planet's atmosphere, and the factors that led to major changes in the Martian climate. It would also provide much needed information on the magnetic field of Mars. Data collected from this mission would provide insight into the evolution of both Earth and the solar system, as well as demonstrate technological approaches that could be applicable to future Mars missions.

MISSION DESCRIPTION

The MGS mission would be one of the first in a proposed program of robotic exploration of Mars. The spacecraft would be placed in a near-circular polar orbit via thruster maneuvering and through the use of aerobraking techniques designed to reduce the amount of propellant required for orbital insertion. The scientific instruments would be activated and begin to map the surface of Mars. The data would be downlinked to Earth via the Deep Space Network (DSN). After the mapping phase, the spacecraft would act as a relay for data from other spacecraft and landed vehicles.

ALTERNATIVES CONSIDERED

Alternatives to the proposed action that were considered included those that: (1) utilize an alternate launch vehicle/upper stage combination, or (2) eliminate the Mars Global Surveyor mission (the No-Action alternative).

Alternate Launch Vehicles

The most desirable launch vehicle for MGS would meet, but not greatly exceed, the mission's minimum launch performance requirements. Other considerations in the selection of a launch vehicle include reliability, cost, and potential environmental impacts associated with the use of the vehicle. Of the several alternative U.S. and foreign launch vehicles considered, the Delta II 7925 most closely matches the MGS mission requirements:

- The mass performance of the Delta II 7925/PAM-D most closely matches the MGS performance requirement.
- The Delta II 7925/PAM-D is the more reliable alternative launch system of those systems meeting the MGS performance criteria.
- The Delta II 7925/PAM-D is the lower cost alternative launch system of those systems meeting the MGS performance criteria.
- Of the reasonable alternative launch systems examined, all were approximately equal in their potential environmental impacts.

No-Action Alternative

The proposed action is to complete the integration and launch the MGS spacecraft. The alternative to the proposed action is no-action. This alternative would result in termination of the mission, which would disrupt the progress of NASA's Inner Solar System Exploration Program. For Mars, the Program calls for progressively more detailed reconnaissance by spacecraft and robotic explorers. The No-Action alternative would delay or prevent the demonstration of technologies critical to future exploration of Mars. While minimal environmental impacts would be avoided by cancellation of the single launch, the loss of the scientific knowledge and database that could lead to future technological advances would be significant.

SUMMARY OF ENVIRONMENTAL IMPACTS

The only expected environmental effects of the proposed action are associated with normal launch vehicle operation and are summarized below.

Air Quality

In a normal launch, exhaust products from a Delta II launch are distributed along the launch vehicle's path. The quantities of exhaust are greatest at ground level and decrease continuously as the vehicle gains altitude. The portion of the exhaust plume that persists longer than a few minutes (i.e., the ground cloud) is emitted during the first few seconds of flight and is concentrated near the pad area. The ground cloud resulting from a normal Delta II launch is predicted to have a radius of about 20 meters (m) (67 feet [ft]).

Hydrogen chloride (HCl) concentrations in the Delta II exhaust plume should not exceed 5 ppm beyond about 4.3 kilometers (km) (2.7 miles [mi]) in a downwind direction. The nearest uncontrolled area (i.e., general public) is about 4.8 km (3 mi) from LC-17. Appropriate safety measures would be taken to ensure that the permissible exposure limits defined by the Occupational Safety and Health Administration (OSHA) (5 parts per million [ppm] for an 8-hour time-weighted exposure limit) are not exceeded for personnel in the launch area.

To estimate the peak ground level concentrations of ground cloud pollutants, the U.S. Air Force has extrapolated Delta II exhaust plume diffusion data from models developed for the Titan launch vehicle program. These Titan models are used to calculate peak ground level concentrations of various pollutants in ground clouds. Due to the similarity in propellant types, the Delta vehicle ground cloud would be similar in composition to that produced by the Titan. However, the size of the Delta ground cloud should be considerably smaller than that of the Titan because the Delta vehicle and solid rocket GEMs contain significantly less propellant, produce less vapor, and accelerate off the launch pad more quickly than the Titan.

Based upon these comparative studies and the distance to the nearest uncontrolled area, HCl concentrations are not expected to be high enough to be harmful to the general population. Although National Ambient Air Quality Standards (NAAQS) have not been adopted for HCl, the National Academy of Sciences (NAS) developed recommended limits for short-term exposure to HCl, ranging from 20 ppm for a 60-minute exposure to 100 ppm for a 10-minute exposure. The maximum level of HCl expected to reach uncontrolled areas during preparation and launch of the Delta II would be well below the NAS recommended limits.

The same predictive modeling techniques used for HCl were also applied to CO and Al₂O₃. For Titan launches, CO concentrations were predicted to be less than 9 ppm except for brief periods during actual lift-off. During launch, gases are exhausted at temperatures ranging from 2,000 to 3,000 degrees. Most of the gases then immediately rise to an altitude of about 2,000 feet, where they are dispersed by the prevailing winds. Carbon monoxide gas is expected to rapidly oxidize to carbon dioxide (CO₂) in the atmosphere, and

therefore, CO concentrations for Titan launches are not expected to exceed the NAAQS of 35 ppm (1-hour average) beyond the immediate vicinity of the launch complex. The nine GEMs used for the Delta launch constitute less than 20 percent of the propellant loading of the two Titan IV-Type 2 SRMUs, and therefore, the CO concentration for a Delta launch is predicted to be on the order of 2 ppm (1-hour average).

Aluminum oxide exists as a crystalline dust in solid rocket motor (SRM) exhaust clouds, but is inert chemically and is not toxic. However, since many of the dust particles are small enough to be retained by lungs, it is appropriate to abide by NAAQS for particulate matter smaller than 10 microns (PM-10). The maximum 24-hour Al_2O_3 concentration beyond the distance of the nearest CCAS property boundary predicted by the model for a Titan IV-Type 2 launch was $25 \mu\text{g}/\text{m}^3$, which is well below the 24-hour average PM-10 NAAQS for PM-10 of $150 \mu\text{g}/\text{m}^3$. [USAF 1990] Scaling from the Titan IV predictions, based on the solid propellant mass proportion of the Delta II 7925, the Al_2O_3 peak concentrations should not exceed $5 \mu\text{g}/\text{m}^3$. The NAAQS for continuous emitters of particulate matter should not be exceeded by a Delta II launch due to the short nature of the launch event.

Nitrogen oxides (NO_x) may enter the atmosphere through propellant system venting, a procedure used to maintain proper operating pressures. Air emission control devices will be used to mitigate this small and infrequent pollutant source. First stage propellants will be carefully loaded using a system with redundant spill-prevention safeguards. Aerozine 50 vapors from second stage fuel loading will be processed to a level below analytical detection by a citric acid scrubber. Likewise, N_2O_4 vapors from second stage oxidizer loading will be passed through a sodium hydroxide (NaOH) scrubber. These scrubber wastes will be disposed of by a certified hazardous waste contractor.

During the last 20 years there has been an increased concern about human activities that are affecting the upper atmosphere. Space vehicles that use SRMs have been studied concerning potential contribution to stratospheric ozone depletion because of their exhaust products, with the primary depleting component being HCl. Extrapolating from estimates made using the model for the Titan IV solid rocket motor upgrades' (SRMUs) effects on stratospheric ozone, the net decrease in ozone resulting from launching eight Titan IV-Type 2 (SRMUs) over a twelve-month period is predicted to be on the order of 0.02 percent. [USAF 1990] A Delta II 7925 with nine GEMS is less than 20 percent of the SRMUs propellant loading. Therefore, scaling from the Titan IV-Type 2 prediction, the net stratospheric ozone depletion from nine GEMS, which are planned for use with the Delta II, has been predicted to be on the order of 0.0005 percent. History shows that there have been an average of six Delta launches per year for the past eight years. Assuming this average, launching six Delta II 7925s with nine GEMs in a twelve-month period is extrapolated to result in a cumulative net stratospheric ozone depletion on the order of 0.003 percent.

Since the ground cloud for a Delta II launch is very small (about 20 m or 67 ft) and concentrates around the launch pad, there should be no substantial acid rain beyond the near-pad area.

Land Resources

Overall, launching a Delta II vehicle would not be expected to have significant negative effects on the land forms surrounding LC-17. However, launch activities could have some small impacts near the launch pad associated with fire and acidic depositions. Minor brush fires are infrequent by-products of Delta launches, and are contained and limited to the ruderal vegetation within the launch complexes; past singeing has not permanently affected the vegetation near the pads. Wet deposition of HCl could damage or kill vegetation, but would not be expected to occur outside the pad fence perimeter.

Local Hydrology and Water Quality

Water, supplied by municipal sources, is used at LC-17 for fire suppression (deluge water), launch pad washdown, and potable water. The deluge water would be collected in the flume located directly beneath the launch vehicle and flow into a sealed concrete catchment basin, where it would then be disposed of in accordance with applicable federal and state regulations and permit programs. A concrete exhaust flume on each pad deflects exhaust gases away from the pad to reduce the noise and shock wave that result from ignition of solid rockets and the first stage of the launch vehicle. Most of the pad washdown and fire suppressant water would also be collected in a concrete catchment basin, and any propellant release would occur within sealed trenches and should not contaminate runoff. If the catchment basin water meets federal discharge criteria, it would be discharged directly to grade at the launch site. If it fails to meet the criteria, it would be treated on site and disposed to grade or collected and disposed of by a certified contractor. [USAF 1988]

The primary surface water impacts from a normal Delta II launch involve HCl and Al_2O_3 deposition from the exhaust plume. The ground cloud would not persist or remain over any location for more than a few minutes. Depending on wind direction, most of the exhaust may drift over the Banana River or the Atlantic Ocean. A brief acidification of surface waters may result from HCl deposition. A normal Delta II launch would have no significant impacts to the local water quality due to amount of water available for dilution.

Ocean Environment

In a normal launch, the first and second stages and the SRMs would impact the ocean. The trajectories of spent stages and SRMs would be programmed to impact at a safe distance from any U.S. coastal area or other land mass. Toxic concentrations of metals would not be likely to occur due to the slow rate of corrosion in the deep ocean environment and the large quantity of water available for dilution.

Spent stages would have relatively small amounts of propellant. Concentrations in excess of the maximum allowable concentration (MAC) of these compounds for marine organisms would be limited to the immediate vicinity of the spent stage. No substantial impacts would be expected from the reentry and ocean impact of spent stages, since the amount of residual propellants is small when compared with the large volume of water available for dilution.

Biotic Resources

A normal Delta II launch would not be expected to substantially impact CCAS terrestrial, wetland, or aquatic biota. The elevated noise levels of a launch are of short duration and would not substantially affect wildlife populations. Wildlife encountering the launch-generated ground cloud could experience brief exposure to exhaust particles, but would not experience any substantial impacts. If the launch were to occur immediately before a rain shower, aquatic biota could experience acidified precipitation. This impact would be expected to be insignificant due to the brevity of the small ground cloud and the high buffering ability of the surrounding surface waters to rapidly neutralize excess acidity.

Radioactive Materials

The proposed design of this spacecraft includes no radioactive materials. Thus, there is no radiological risk to the health and safety of human life or the environment from this mission.

Threatened and Endangered Species

Any action that may affect Federally listed species or their critical habitats requires consultation with the U.S. Federal Wildlife Service (FWS) under Section 7 of the Endangered Species Act of 1973 (as amended). The U.S. FWS has reviewed those actions which would be associated with a Delta II launch from LC-17 and has determined that those actions would have no effect on state or federally listed threatened (or proposed for listing as threatened) or endangered species residing on CCAS and in adjoining waters or critical habitats.

Population and Socioeconomics

The MGS mission would create negligible impact on local communities, since no additional permanent personnel would be expected beyond the current CCAS staff. Launch Complex 17 has been used exclusively for space launches since the late 1950s. The MGS mission would cause no additional adverse impacts on community facilities, services, or existing land uses.

Safety and Noise Pollution

Normal operations at CCAS include preventative health measures for workers such as hearing protection, respiratory protection, and exclusion zones to minimize or prevent exposure to harmful noise levels or hazardous areas or materials.

The engine noise and sonic booms from a Delta II launch are typical of routine CCAS operations. In the history of USAF space-launch vehicle operations at CCAS, there have been no problems reported as a result of sonic booms. To the surrounding community, the noise from this activity appears, at worst, to be an infrequent nuisance rather than a health hazard.

Cultural Resources

Since no surface or subsurface areas would be disturbed, no archeological, historic, or other types of cultural sites would be expected to be affected by launching the MGS mission.

POTENTIAL LAUNCH ACCIDENTS

Liquid Propellant Spill

The potential for an accidental release of liquid propellants will be minimized by strict adherence to established safety procedures. Post-fueling spills from the launch vehicle will be channeled into a sealed concrete catchment basin and disposed of according to the appropriate state and federal regulations.

The most severe propellant spill accident scenario would be releasing the entire launch vehicle load of nitrogen tetroxide (N_2O_4) at the launch pad while conducting propellant transfer operations. This scenario would have the greatest potential impact on local air quality. Airborne NO_x levels from this scenario are expected to be reduced to 5 ppm within about 150 m (500 ft) and to 1 ppm within approximately 300 m (1,000 ft). Activating the launch pad water deluge system would substantially reduce the evaporation rate, limiting exposure to concentrations that are above federally established standards to the vicinity of the spill. Propellant transfer personnel would be outfitted with protective clothing and breathing equipment. Personnel not involved in transfer operations would be excluded from the area.

Launch Vehicle Destruction

In the unlikely event of a launch vehicle destruction, either on the pad or in-flight, the liquid propellant tanks and SRM cases would be ruptured. Due to their hypergolic (ignite on contact) nature, a launch failure would result in a spontaneous burning of most of the liquid propellants, and a somewhat slower burning of SRM propellant fragments. Any such release of pollutants would have only a short-term impact on the environment near the pad.

Launch failure impacts on water quality would stem from unburned liquid propellant being released into CCAS surface waters. For most launch failures, propellant release into surface waters would be substantially less than the full fuel load, primarily due to the reliability of the vehicle destruct system. However, if there were an early flight termination and failure of the vehicle destruct system, it is remotely possible that the entire Stage II propellant quantity could be released to the ocean. Impacts to ocean biotic systems would be localized, transient in nature, and these systems would be expected to recover rapidly, due to the large amount of ocean water available for dilution.

SECTION 1

PURPOSE AND NEED

The National Aeronautics and Space Administration (NASA) has prepared an Environmental Assessment (EA) for the Proposed Action of preparing for and implementing the Mars Global Surveyor (MGS) mission, including integration of the MGS spacecraft and its launch from Cape Canaveral Air Station (CCAS), Launch Complex 17 (LC-17), in November 1996. This EA discusses the mission's objectives as well as its potential environmental impacts. Possible alternatives to the proposed action are also examined. Among the possible effects that will be considered are air and water quality impacts, local land area contamination, adverse health and safety impacts, the disturbance of biotic resources, socioeconomic impacts, and adverse effects in wetland areas and areas containing historical sites. This document was completed in accordance with the National Environmental Policy Act (NEPA) of 1969, as amended (42 U.S.C. 4321, et seq.), the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500-1508), Executive Order 12114, Environmental Effects Abroad of Major Federal Actions, and NASA's policy and implementing procedures (14 CFR Subpart 1216.3).

1.1 PURPOSE OF THE PROPOSED ACTION

The National Aeronautics and Space Act of 1958 (42 U.S.C. 2451(d)(5)) established a mandate to conduct activities in space that contribute substantially to the expansion of human knowledge, and to "the preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere." In response to this mandate, NASA, in coordination with the National Academy of Sciences (NAS), has developed a prioritized set of science objectives to be met through a long-range program of planetary missions (i.e., the U.S. Solar System Exploration Program). These missions are designed to be conducted in a specific sequence based on technological readiness, launch opportunities, timely data return, and a balanced representation of scientific disciplines.

NASA's strategy to carry out this sequence consists of an orderly progression from flyby-type reconnaissance missions, to investigation with orbiters and atmospheric probes, to intensive study involving landers, sample return, and human exploration. In addition, these three phases of planetary exploration are being applied to each of the three regions of the solar system: the inner solar system (terrestrial planets), the primitive bodies (comets and asteroids), and the outer solar system (the gas giants and Pluto). Emphasis in mission selection is on continuity, commonality, and cost-effectiveness.

In 1978, following the successful Viking Orbiter and Lander missions to Mars, the National Academy of Science's Committee on Planetary and Lunar Exploration identified a list of prioritized objectives for post-Viking Mars exploration. In 1983, the Solar System Exploration Committee of the NASA Advisory Council recognized that achieving the major objectives of a Mars exploration program would require establishing and operating long-lived science stations at diverse Martian locations to perform seismic, meteorological, and geoscience measurements. In order to fulfill these objectives in a cost-effective manner, it is imperative that detailed information on the surface and atmosphere of Mars be obtained. Mars Observer was to be the first Planetary Observer mission, and was designed to address geoscience and climatology objectives by remote sensing from a near-polar orbit. [NASA 1986] Mars Global Surveyor is being designed to gather most of the science originally planned to be obtained by Mars Observer, which was lost in August 1993. MGS supports two of the Solar System Exploration Program's primary objectives: (1) to understand the origin, evolution, and present state of the solar system; (2) to understand the Earth through comparative planetary studies.

The purpose of the MGS mission is to place a single polar-orbiting spacecraft at Mars in 1997 in order to fulfill most of the critical science objectives of the failed Mars Observer mission. To satisfy this purpose, the MGS spacecraft would carry a portion of the Mars Observer instrument payload, and would use those instruments to acquire Mars surface data for a full Martian year (approximately two Earth years). MGS would provide significant data in support of possible future missions, including relay capability for surface science stations and landers. The instruments and objectives of the MGS mission are described in Section 2 of this EA.

In February 1994, NASA directed the Jet Propulsion Laboratory (JPL) to "plan and implement an aggressive Mars exploration program called the Mars Surveyor Program." [NASA 1994-A] The broad science objectives of such a program are to characterize the Martian environment in terms of atmospheric structure, global atmospheric circulation, surface morphology and geology, surface geochemistry, surface elemental composition, internal planet structure, variations in the Martian gravitational field, and the planet's size and shape. The data obtained by MGS, as well as its relay capability, would aid the Mars Surveyor Program in meeting its objectives.

1.2 NEED FOR THE PROPOSED ACTION

Earth and Mars are related inner solar system planets composed of rocky silicate material and possessing substantial atmospheric cover. Mars was one of the first celestial bodies to be extensively studied by telescope; its distance from the earth ranges from 70 to 400 million km (44 to 249 million mi). Mars has a radius of only 3,394 km (2,121 mi), compared to Earth's 6,378 km (3,964 mi), and a weaker gravitational field (only 38 percent that of Earth's).

Previous explorations of Mars have revealed an intriguing world of large mountains and deep canyons, and a surface etched by the erosion of wind and ancient floods. Part of its

surface resembles the earth's moon, and shows massive impact basins, cratered highland regions, and extensive flooding by lavas. Other surface regions resemble Earth's mountains, volcanoes, dried-up riverbeds, desert sand dunes, and seasonal polar caps. Mars has evolved to an advanced stage, approaching the development level of Earth; its internal heat may still be producing volcanic activity and outgassing internal gases into the atmosphere.

Mars is the only other terrestrial planet known to have surface-accessible water. Like Earth, Mars has polar caps composed of frozen volatiles, including water. In addition, water may be locked up as ground ice and liquid water below the surface, and adsorbed on minerals or in surface rocks. Although liquid water is not stable under the current conditions on the Martian surface, there is evidence for what may have been large outflow channels across the surface in the past, as well as small, stream-like channels in the ancient crust that are suggestive of surface runoff resulting from rain. The scale of the Martian features has led planetary scientists to theorize that the water must have been recycled for long periods in a hydrologic cycle. Also, these ancient terrains give evidence for lakes or smaller standing bodies of water. Some researchers have suggested the presence of surface oceans on Mars that filled the northern lowlands of the planet, not unlike oceans on Earth. If true, Mars had a warmer and wetter past and has undergone major climatic changes during its history. Knowledge of the distribution, amount, and forms of water on Mars will lead to a greater understanding of the role that water has played in the various geologic processes that shaped its surface. Understanding what has happened to the water on Mars and its relation to major changes in climate thus may have a strong bearing on understanding major climatic fluctuations that have occurred on Earth, such as the ice ages.

Although both Mars and Earth have a long and varied history of mantle activity, there is no evidence of plate tectonics on Mars, and little is known of the chemical composition of its volcanic rocks and lavas. Mars' surface reveals evidence of volcanic, alluvial, glacial, eolian, and tectonic processes that have led to stratigraphic systems, structural relation, and landforms that are generally understandable from a terrestrial perspective.

Mars has an atmosphere with variable cloud patterns, but it is thin (only 1/100 as dense as Earth's), dry, and cold (the average minimum temperature at the equator is -100°C , or about -148°F), and provides little protection from solar ultraviolet radiation, rendering the planet's surface hostile to life as we know it. Mars experiences readily measurable seasonal changes due to the 25° tilt of its axis, which is almost identical to Earth's 23.5° tilt. However, its global atmospheric dynamics, the distribution and transport of vaporized materials during the Martian year, and the structure and photochemistry of the upper atmosphere are not well characterized. Even the existence and strength of an intrinsic Martian magnetic field remain poorly understood.

Every object in the solar system contains part of the record of planetary origin and evolution. These geologic records are in the form of chemical and isotopic 'fingerprints', as well as in the stratigraphic sequences, structural relationships, and morphology of land forms. The exploration of Mars has reinforced the opinion held by the scientific community that many planetary processes, including some that operate on Earth, may be universal.

Significant insights into the evolution of Mars have been gained from previous explorations, but large gaps in scientific knowledge still remain. Detailed data on the Martian atmosphere and surface are needed to help answer some of the questions about the history and current state of water on Mars, the evolution of the planet's atmosphere, and the factors that led to major changes in the Martian climate. The MGS mission would provide data that could possibly answer some of these questions, as well as provide a demonstration of technological approaches that could be applicable to future Mars missions.

Initially, the MGS mission would obtain global maps of the elemental and mineralogical character of the surface materials, topography, and planetary gravitational and magnetic fields. The maps could then be used to evaluate the distribution of chemical elements and minerals in relation to the age, morphology, emplacement mode, and weathering of the surface material. By focusing on surface science, the mission would make a substantial contribution to the development of future landed missions. Following the mapping phase of its mission, MGS would then be available to serve as a data relay station for signals from other future landed missions.

SECTION 2

PROPOSED ACTION AND ALTERNATIVES

2.1 PROPOSED ACTION

This section describes the Proposed Action of preparing and implementing the Mars Global Surveyor mission, including integration of the MGS spacecraft with a Delta II 7925 launch vehicle, and launch from Launch Complex-17 at Cape Canaveral Air Station. Alternatives to this Proposed Action, including the No-Action alternative, are discussed in Section 2.2.

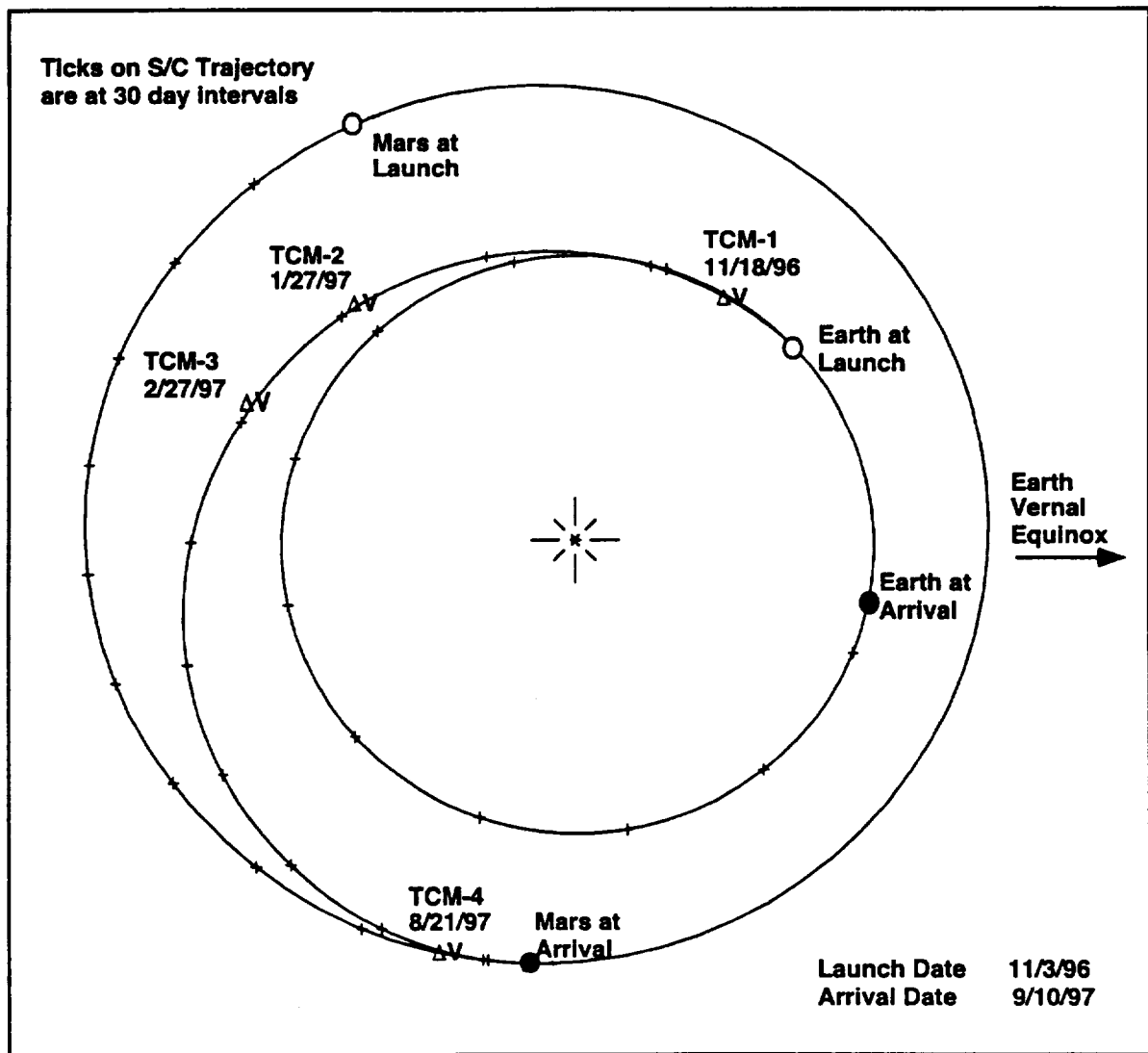
2.1.1 MISSION DESCRIPTION [JPL 1994-A], [JPL 1994-B]

The Mars Global Surveyor mission involves placing a single polar-orbiting spacecraft at Mars in 1997 to fulfill the most critical science objectives of the failed Mars Observer mission. Current plans call for using a Delta II 7925/Payload Assist Module-Delta (PAM-D) launch vehicle/upper stage combination to inject the MGS spacecraft into an Earth-Mars trajectory (Figure 2-1) in November 1996. After a ten-month flight, MGS would be inserted into an elliptical capture orbit in September 1997 and, over the next four-month period, would use thruster firings and aerobraking techniques to reach a nearly circular, low-altitude, polar mapping orbit. Aerobraking, a technique which uses the forces of atmospheric drag to slow the spacecraft for orbital maneuvers, would provide a means of minimizing the amount of fuel required to reach the final low Mars mapping orbit. During the next three months, the orbit would evolve into the final mapping orbit, which would allow the spacecraft to be illuminated by the Sun in the same way throughout the Martian year. Scientific instruments would be calibrated, and the spacecraft would be configured for mapping operations, which would then begin in April 1998 and last approximately two years.

The mission design calls for the spacecraft to circle Mars once every two hours, maintaining a Sun-synchronous orbit that would put the Sun at a standard angle above the horizon in each image and allow the mid-afternoon lighting to cast shadows in such a way that surface features would stand out. As the spacecraft travels along its nearly circular polar orbit, the planet turns on its axis below it. Every seven days the spacecraft would track the same general ground area, but since the planet has rotated beneath it, the swath seen by the MGS instruments would be slightly offset from the previous data set. This offset allows global coverage to be built up from repeated instrument swaths, thus enabling MGS to provide nearly complete planetary coverage.

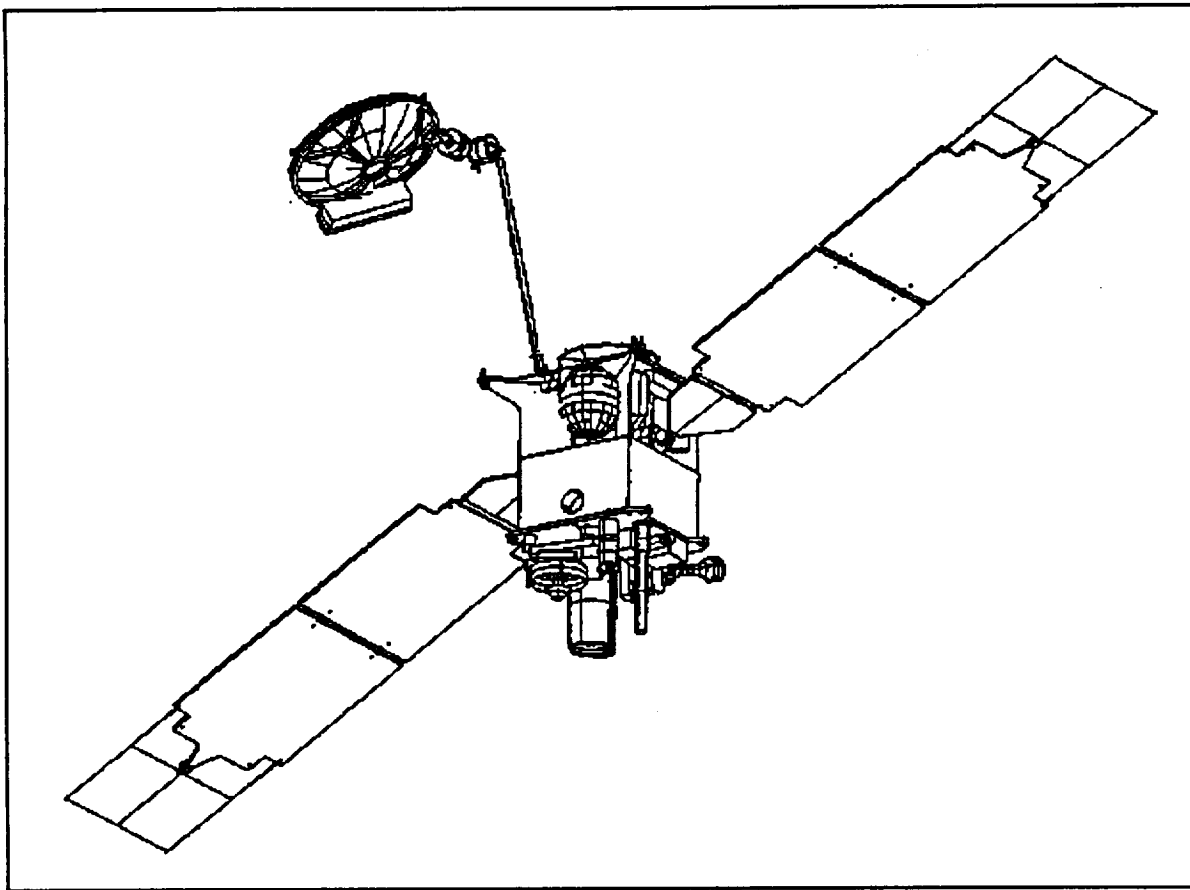
From April 1998 through March 2000, the spacecraft would record and store onboard science data for approximately 24 hours each day, and then play it back to the Deep Space Network (DSN) in one tracking-station pass that day. Approximately every third day, an additional tracking-station pass would be scheduled to return high-rate, real-time data. After completion of the mapping phase, MGS would support the Mars Surveyor Program by relaying

data from various landers and atmospheric vehicles to the earth. This relay support phase would begin in April 2000 and continue for three years. At the end of the relay phase of the mission, an orbit raise maneuver would be required to place MGS in a near-circular orbit with an average altitude sufficiently high to reduce the probability of the spacecraft entering the Martian atmosphere prior to the year 2046 [JPL 1995-C], and thereby satisfy the requirements of NASA's Planetary Protection Policy (discussed in paragraph 2.1.5.2.1). [NASA 1994-B]



Source: [JPL 1994-B]

Figure 2-1. MGS Earth-Mars Trajectory for Earliest Launch Date



Source: [JPL 1994-B]

Figure 2-2. MGS Mapping Orbit Configuration

2.1.2 MISSION SCIENCE OBJECTIVES [JPL 1994-B]

The science objectives for the MGS mission would be to complete, as fully as possible, the original science objectives of the Mars Observer mission. The Mars Global Surveyor science objectives were derived from the recommendations of the Solar System Exploration Committee in their report, "Planetary Exploration Through Year 2000: A Core Program." [NASA 1983] The areas of scientific investigation for the MGS mission are summarized in the following paragraphs. Table 2-1 on page 2-8 is a matrix showing which instrument or combination of instruments would be used to gather data to meet the science objectives.

2.1.2.1 Characterize Surface Morphology at High Spatial Resolution to Quantify Surface Characteristics and Geological Processes

MGS would use the flight spare of the Mars Orbiter Camera (MOC), which would acquire images of the surface and atmosphere of Mars for qualitative and quantitative

photographic interpretation. A combination of scientific instruments onboard the spacecraft would provide data to supplement the photographic information.

2.1.2.2 Determine the Composition and Map the Distribution of Surface Minerals, Rocks, and Ices; Measure the Surface Thermophysical Properties

The Thermal Emission Spectrometer (TES), in combination with MOC images, would be used to collect data on the composition, particle size, and distribution of atmospheric dust. The same capability would be used to locate and determine the properties of water-ice and condensate clouds, and provide information on the condensate properties, processes, and energy balance of the polar caps.

2.1.2.3 Map the Global Topography, Determine the Geodetic Figure (Global Size and Shape), and Establish the Nature of the Gravitational Field of Mars

The Mars Orbiter Laser Altimeter (MOLA) carried onboard the spacecraft would generate high-resolution topographic profiles of Mars for studies of geophysical and geological structures and processes. These data would be supplemented by data from the MOC and TES instruments.

The radio Doppler tracking capability of the spacecraft would provide improved observations of the spacecraft motion around Mars by at least a factor of ten better than that obtained by the Viking and Mariner missions. These observations would yield information on the structure of the Martian gravitational field through measurement of its effect on spacecraft motion. These data would be expected to yield unprecedented spatial resolution and global coverage, as well as determine the accuracy of the derived gravitational field model, which describes the mass distribution of the planet. The data would also provide important keys to Mars' internal structure and inferences of the planet's evolution; for example, does Mars have a core, is the crust thick or thin, are the great Martian volcanoes "floating" on the surface crust or will they eventually sink into it?

2.1.2.4 Establish the Existence of, and Investigate the Nature of, the Magnetic Field; Map the Crustal Remnant Field

During the mapping orbit phase, the Magnetometer/Electron Reflectometer (MAG/ER) aboard the spacecraft would obtain data that would be used to determine the existence and characteristics of the global magnetic field, characterize any surface magnetic features, and determine the nature of the Mars/solar wind interaction.

2.1.2.5 Monitor Global Weather and Thermal Structure of the Atmosphere

Experiments carried out by the MOC, TES, and Radio Science instruments would provide data to advance the study of the polar atmosphere, by providing consistent and accurate long-term monitoring of total gas content and the vertical structure of the neutral atmosphere.

These data would complement and extend other types of Mars atmospheric observations in that they offer the potential for superior accuracy and vertical resolution, and can be obtained reliably in a dusty atmosphere (refer to Table 2-1).

2.1.2.6 Study Surface-Atmosphere Interaction by Monitoring Surface Features, Polar Caps, Polar Thermal Balance, Atmospheric Dust, and Condensate Clouds Over a Seasonal Cycle

The global monitoring mode of the spacecraft would provide daily, full-planet observations of the atmosphere and surface to document changes over time. The regional monitoring mode would observe selected atmospheric phenomena and surface features at high resolution.

2.1.3 SPACECRAFT DESCRIPTION [JPL 1994-B]

2.1.3.1 General

The Mars Global Surveyor spacecraft would provide a three-axis stabilized platform for observations of Mars by the science payload. The design is derived in large part from the Mars Observer spacecraft, with necessary modifications made to incorporate the action plans from the Mars Observer failure reports. The design is based on the Magellan aerobraking experience.

2.1.3.2 Spacecraft Pyrotechnic Devices

The MGS spacecraft would use a total of 28 (14 primary, 14 backup) pyrotechnic devices, all classified as Category B. All are NASA Standard Initiators (NSIs) and would be used in pyro-activated valves in the propulsion system. The design includes 11 non-pyrotechnic burnwire separation devices, which would be used for releasing the high gain antenna and solar arrays. Installation would be performed at the Kennedy Space Center (KSC) Payload Hazardous Servicing Facility (PHSF) during check-out and propellant loading of the spacecraft.

2.1.3.3 Science and Engineering Instrumentation

The scientific instruments onboard MGS would be used singly and in combination to gather data required to meet the science objectives. Table 2-1 on page 2-8 is a matrix which shows how the instruments will be employed.

2.1.3.3.1 Magnetometer/Electron Reflectometer (MAG/ER)

The magnetometer (MAG) has two sensors, one on the end of each solar array. These sensors would measure the three mutually perpendicular components of the magnetic field, thereby providing the direction and magnitude of the background field at the sensor. The electron reflectometer (ER) would measure the energy spectrum and angular distribution of the electrons arriving at the sensor. The two MAG sensors and one ER sensor share a common data processing unit, allowing the data to be combined and reduced before being downlinked to Earth.

2.1.3.3.2 Mars Orbiter Camera

The MOC would consist of two wide-angle (140 degree field-of-view, low resolution) and one narrow-angle field-of-view (high resolution) optical assemblies, which would share common electronics for storing and processing the data. In the High Resolution mode, the narrow-angle optics would be used to sample important areas of the planet, while simultaneous wide-angle images would provide positional and meteorological context for the narrow-angle frames. Each optical assembly would use a Charge Coupled Device (CCD) line array. CCDs are high-technology silicon chips that convert light directly into electronic or digital images, which can then be manipulated by computers.

2.1.3.3.3 Mars Orbiter Laser Altimeter

The Mars Orbiter Laser Altimeter would be assembled from some of the original instrument spare parts. The MOLA would be a laser diode-pumped, pulsed Nd-YAG laser operating at an infrared wavelength of 1.06 μm . It would have an output power of 45 millijoules (mJ) per pulse. The receiving optics would focus the return signal on a silicon avalanche photodiode detector. The accuracy in measuring the topography relative to other features on the surface would vary from 1 to 10 m (3 to 32 ft), depending on surface slopes. The absolute accuracy of the instrument would be approximately 30 m (98 ft), depending largely on precise reconstruction of the spacecraft orbital position from the radio science gravity field results. A secondary result of this experiment would be surface reflectance profiles at the 1.06 μm wavelength.

2.1.3.3.4 Thermal Emission Spectrometer (TES)

The Thermal Emission Spectrometer (TES) would be a combined infrared spectrometer and radiometer designed to map the thermal and reflected-visible energy from the surface and atmosphere of Mars. It consists of a telescope, interferometer (spectrometer), and scan mirror with horizon-to-horizon pointing capability. The scanning mirror, along with the spacecraft motion, permits the TES to map the surface and atmosphere of Mars with 3 km (1.9 mi) spatial resolution. The TES has three sets of 2 x 3 detector arrays, one set for the spectrometer range of 6.25 μm to 50 μm , one set for the reflectance radiometer range of 0.3 μm to 2.7 μm , and one set for the broadband radiometer range of 4.5 μm to 100 μm . The spectrometer channels will map the mineralogical composition of the surface. The radiometric channels will map the surface and atmospheric thermal and physical properties.

2.1.3.3.5 Radio Science Investigation (RS)

Radio occultation and tracking experiments carried out with Mars Global Surveyor, in combination with the DSN and Earth ground station, would advance both atmospheric observations and gravitational field information via radio Doppler tracking, two areas fundamental to the study of Mars. Radio occultation observations of the polar atmosphere would provide consistent and accurate long-term monitoring of total gas content and the vertical structure of the lower atmosphere (from the surface of Mars to a height of about 50 km [31 mi]). These data

would provide superior accuracy and vertical resolution to those obtained by Viking, and can be reliably obtained in a dusty atmosphere because the microwave signals employed for the occultation measurements are not sensitive to the small particles which make up the dust.

It is expected that, by utilizing MGS's improved radio system, the accuracy of measurements taken of Mars' surface and the atmospheric conditions, such as temperature and pressure, would be better than those obtained by the Viking landers, which used instruments physically located on the surface. Signal scintillations, if detectable, would be studied to extend the understanding of small-scale dynamical processes, such as turbulence and waves.

It might also be possible, using the radio science instrumentation in the occultation experiment, to characterize the main ionospheric layer by finding its height and peak ionization, as the phase of the radio signals is also affected by the ionized regions. The Martian ionosphere is very tenuous, however, and this aspect of the experiment would depend on ionospheric conditions at the time of the observations.

When used for radio occultation measurements, the signal transmissions would originate on the spacecraft independently of the earth ground station. For this purpose, the spacecraft would carry a very stable frequency reference, or clock, called the Ultra-Stable Oscillator (USO). Signals from the USO would pass through the atmosphere of Mars and be reflected to the earth-based ground tracking station. On the ground, the same antenna used for tracking would receive and record the signals. The perturbations of the signals by the atmosphere would reveal the atmospheric structure in terms of its temperature and pressure from the surface to an altitude of about 50 km (31 mi). These measurements would be made about once every hour when the spacecraft is being tracked, alternating over the north and south polar regions. Over the course of the Martian year, these measurements should reveal the ways in which the Martian polar caps wax and wane, and exchange material with the atmosphere.

At the same time, the data would help with the interpretation of the radiometric instrument, TES, and the construction of models of the atmospheric circulation and weather. MGS occultation measurements are expected to provide unique characterizations of the Martian atmosphere, unprecedented in accuracy and vertical resolution.

When in orbit around Mars, the speed of the spacecraft would be affected by the variations in the density of Mars from place to place. The motion of the spacecraft in its low-altitude polar orbit would be measured by radio Doppler tracking, utilizing the improved spacecraft telecommunication subsystem. This system would operate on the basis of round-trip transmission of precisely controlled radio signals traveling from a DSN ground station to the spacecraft and back again. This would be accomplished in such a way that, when the signal returns from the spacecraft, precise measurements of the received frequency would yield information on the spacecraft motion during the round trip process. The high degree of accuracy expected would allow the changes in speed associated with the mass density variation to be inferred. Since the amount of mass is related to the strength of the gravitational field, the results would be rendered as a map of the strength of gravity on Mars, and would be described by a mathematical model. Data obtained by MGS are expected to yield a map of these variations with unprecedented spatial resolution, global coverage, and accuracy of the derived gravitational field model.

2.1.3.3.6 Mars Relay (MR)

The Mars Relay (MR) would be a CNES¹-provided radio system designed to return measurements and imaging data from instrumented balloons or landed packages. The data would be routed from the MR to the MOC data buffer for storage and subsequent return in the normal science data stream.

The MR consists of a 1-meter antenna and an electronics package. It would operate in the ultra-high frequency (UHF) range, near 400 MHz, transmitting about 1.3 Watts of radiated power.

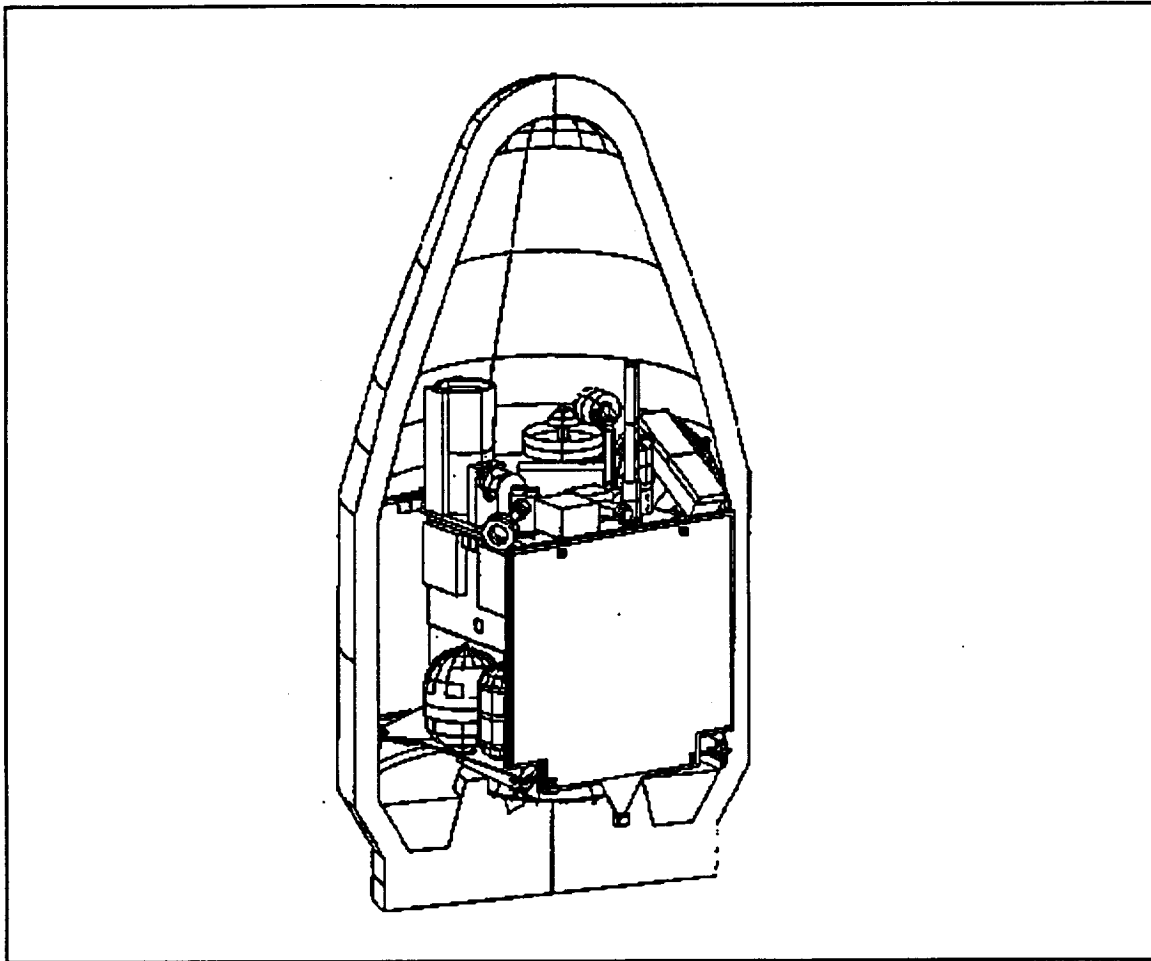
Table 2-1. Mars Global Surveyor Instruments and Science Objectives

SCIENTIFIC OBJECTIVE	INSTRUMENT					
	MAG/ER	MOC	MOLA	TES	RS	MR
Characterize surface morphology - volcanic, alluvial, glacial, eolian, and tectonic processes		X	X	X		
Determine composition of surface minerals, rocks, and ices		X		X		
Map distribution of surface minerals, rocks, and ices		X	X	X		
Measure surface thermo-physical properties				X	X	
Determine global topography			X		X	
Determine geodetic figure		X	X			
Measure gravitational field			X		X	
Measure magnetic field	X					
Map crustal remnant field	X					
Seasonal cycling of the polar caps		X			X	
Monitor global weather and thermal structure of the lower atmosphere		X		X	X	
Collect data on photochemistry of upper atmosphere					X	
Study surface/atmosphere interaction		X		X	X	
Mars relay		X				X

¹ French Space Agency

2.1.4 LAUNCH VEHICLE [MDSSC 1992]

The Delta II 7925 was selected as the baseline launch vehicle for the MGS mission. The Delta II launch vehicle (Figure 2-4) consists of a payload fairing (PLF), the first and second stage propulsion systems with nine graphite epoxy motors (GEMs) used as strap-on boosters to the first stage, and a Payload Assist Module-Delta (PAM-D) upper stage.



Source: [JPL 1995-F]

Figure 2-3. MGS Launch Configuration Inside the Delta II 7925 Payload Fairing

2.1.4.1 Payload Fairing (PLF)

During ascent, the MGS spacecraft/PAM-D upper stage combination would be protected from aerodynamic forces by a 2.9 m (9.5 ft) payload fairing. The PLF would be jettisoned from the launch vehicle during second stage powered flight at an altitude of at least 111 km (69 mi).

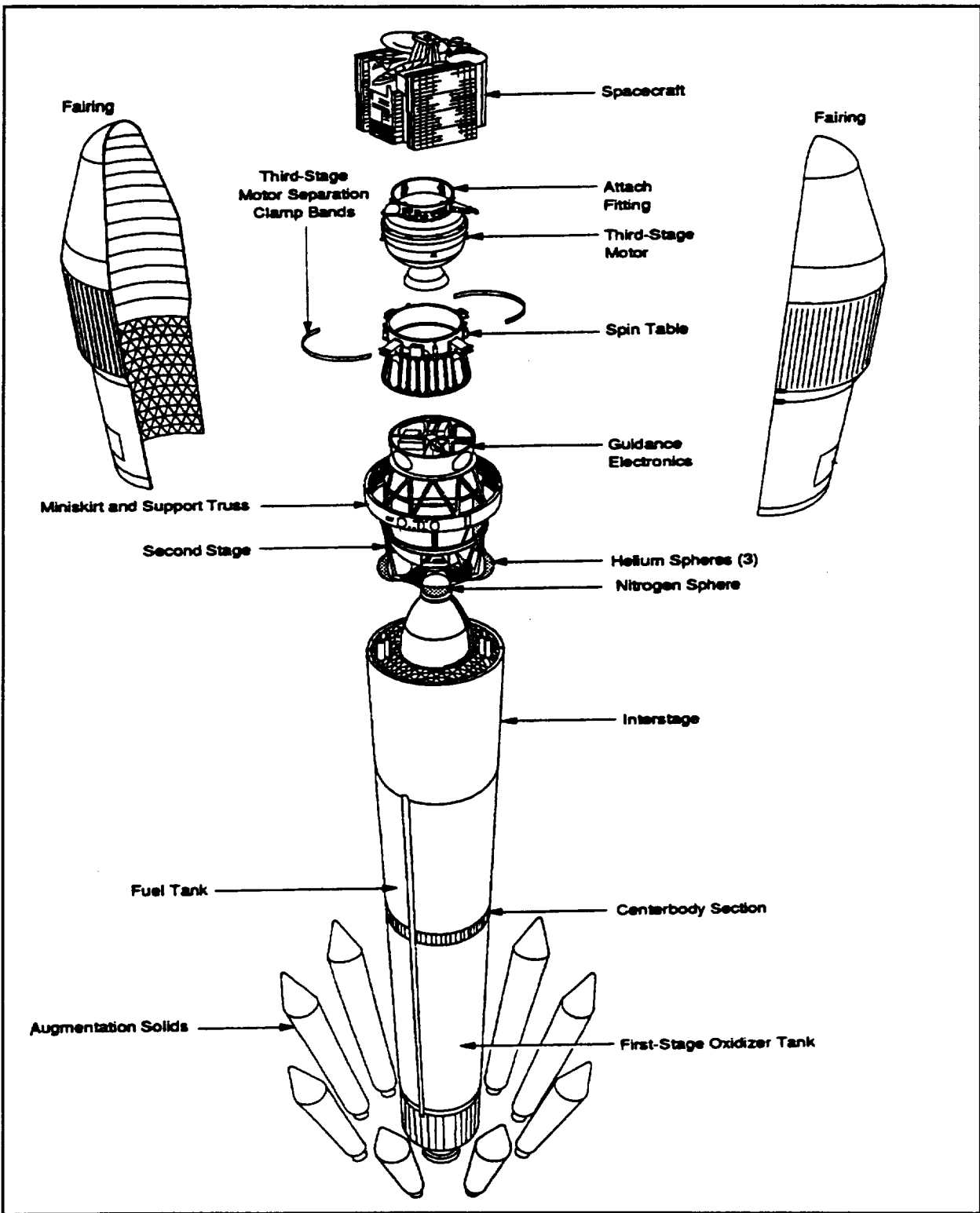


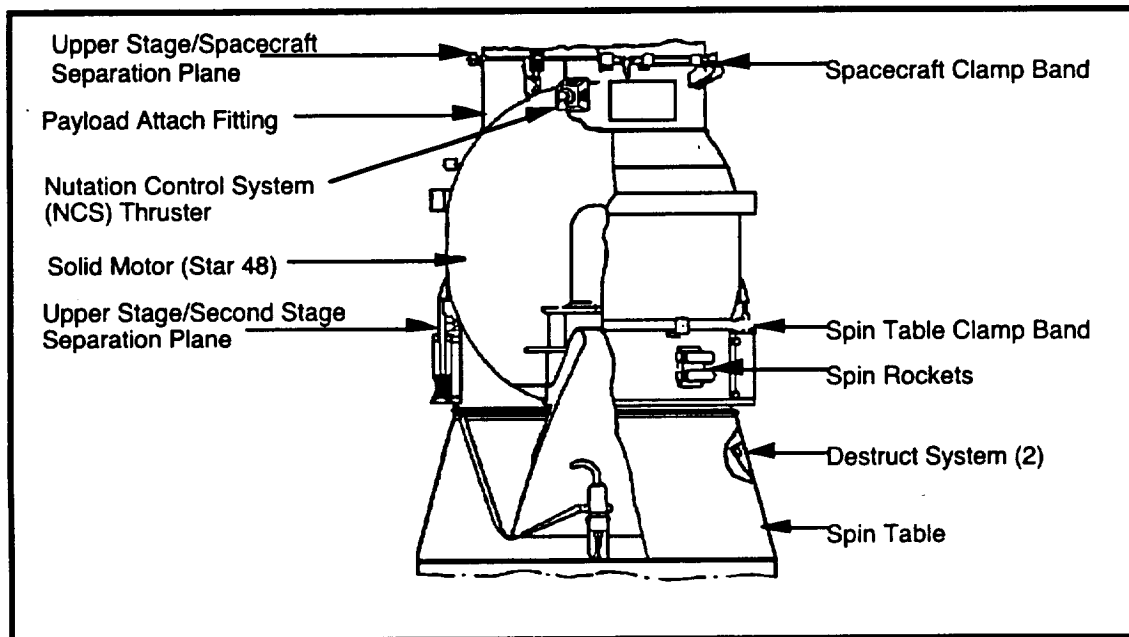
Figure 2-4. Delta II 7925 Launch Configuration

Source: [JPL 1994-B]

2.1.4.2 Delta II First and Second Stage

The first stage of the Delta II is powered by a liquid bipropellant main engine and two vernier engines. The first stage propellant load consists of approximately 96,243 kg (211,735 lb) of RP-1 fuel (thermally stable kerosene) and liquid oxygen as an oxidizer. First stage thrust is augmented by nine GEMs, each fueled with 11,870 kg (26,114 lb) of Hydroxyl-Terminated PolyButadiene (HTPB) solid propellant. The main engine, vernier engines, and six of the GEMs are ignited at liftoff. The remaining three GEMs are ignited in flight. The GEMs are jettisoned after burnout of the solid propellant.

The Delta II second stage propulsion system has a bipropellant engine that uses Aerozine 50 (a 50/50 mix of hydrazine and unsymmetrical dimethyl hydrazine) as fuel and nitrogen tetroxide as oxidizer. The second stage has a total propellant load of 6,019 kg (13,242 lb).



Source: [JPL 1994-B]

Figure 2-5. Payload Assist Module-Delta (PAM-D) Upper Stage

2.1.4.3 PAM-D Upper Stage

The PAM-D is the third stage of the launch vehicle and provides the final velocity required to insert the MGS spacecraft onto the trajectory to Mars. The PAM-D upper stage (Figure 2-5) consists of: (1) a spin table to support, rotate, and stabilize the MGS spacecraft/PAM-D combination before separation from the second stage, (2) a Star 48B solid rocket motor for

propulsion, (3) an active Nutation Control System (NCS) to provide stability after spin-up of the spacecraft/PAM-D stack, and (4) a payload attach fitting to mount the Star 48B motor to the spacecraft. The Star 48B is fueled with 2,010 kg (4,422 lb) of solid propellant. The payload attach fitting, spacecraft separation system, and cabling between the PAM-D and the spacecraft do not remain with the spacecraft after its separation from the upper stage.

2.1.4.4 Flight Termination System (FTS)

The Eastern Range (ER) Range Safety Office would establish flight safety limits for the trajectory of the MGS launch vehicle. These limits are established to ensure that errant launch vehicles (or debris resulting from a launch failure) do not pose a danger to human life or property. These flight safety limits are determined before launch by calculating the range of possible flight azimuths using predicted values for winds, explosively produced fragment velocities, human reaction time, data delay time, and other pertinent data. During a launch, if the vehicle trajectory indicates that these limits would be exceeded, the ER Range Safety Officer would take appropriate action, including destruction of the vehicle. [MMSLS 1991]

As specified by Range Safety requirements, the MGS launch vehicle would be equipped with a Flight Termination System. This system would be capable of destroying the vehicle based on commands sent from the ER Range Safety Officer. In the event of an unplanned separation of the first and second stages, the FTS would automatically issue a destruct command. This function would be activated when electrical paths between stages are interrupted and stage separation commands have not been issued by the flight computer.

An electromechanical Safe and Arm (S&A) device would be located on each of the first and second stages. Upon activation of the FTS, either by a Range Safety destruct command or by sensing vehicle breakup, the S&A device would enable the power and sequence box to trigger the destruction of the vehicle. The first stage S&A device would be connected to several strands of explosive detonating cord, which is attached to the propellant tanks. When activated, these detonations would rupture the tanks, initiating the rapid burning and dispersion of propellants before the vehicle impacts the ground. The second stage S&A device would be connected to a linear shape charge designed to sever the second stage propellant tanks. This device would also be designed to activate the PAM-D FTS by detonating a set of conical shape charges to rupture the motor and render it non-propulsive. [MDSSC 1991]

2.1.4.5 Launch Vehicle Debris

Delta launch vehicles use containment devices to mitigate the spread of debris generated during staging. Once separated, the Delta II payload fairing, first stage, and GEMs would not achieve Earth orbit. The first stage and GEMs would burn to depletion to avoid potential tank rupture and breakup from over-pressurization caused by solar heating. They would then fall into the Atlantic Ocean. Although the second stage would achieve orbit, its orbital decay time would fall below the limit NASA has set for orbital debris consideration. After third stage

separation, the second stage propellants would burn to depletion. The second stage would then remain in low Earth orbit (LEO) until its orbit eventually decayed. The MGS Project has followed the NASA guidelines regarding orbital debris and limiting the risk of human casualty for uncontrolled reentry into the Earth's atmosphere. The MGS spacecraft/PAM-D upper stage would be "parked" in LEO for less than one hour before departing on a hyperbolic trajectory to Mars. Due to these mission characteristics and practices, the launch and operation of the MGS spacecraft is not expected to significantly impact the low Earth orbital environment. [MDA 1993]

2.1.5 CAPE CANAVERAL AIR STATION OPERATIONS (CCAS)

A total of 187 Delta launches have occurred from CCAS Launch Complex 17 since May of 1960. During this long period of federally sponsored activities, launch preparation procedures have been well documented, standardized, and continuously reviewed. MGS launch personnel would be trained to follow established procedures.

Safe hardware and support equipment would be used to ensure safety for both personnel and equipment during all phases of fabrication, test, and operation. A Project Safety Plan (PSP) and a Missile System Pre-Launch Safety Package (MSPSP) would be prepared in accordance with JPL, KSC, and Air Force ER Range Safety Office requirements. A Safety Review Panel (SRP) High-Performance Work Team, as specified by Eastern Range Regulation (ERR) 127-1, would be convened and meet as required to review and guide the resolution of safety issues. The SRP would also provide recommended dispositions for the MSPSPs, which would be submitted to the Air Force.

2.1.5.1 Launch Vehicle Processing

The Delta II first and second stages would be initially received, inspected, and stored at Hangar M (Figure 2-6). They would then be moved to the Delta Mission Check-Out (DMCO) Building for hardware integration and systems testing. The first stage would then be transferred to the Horizontal Processing Facility (HPF) for installation of the destruct ordnance package, and prepared for erection at the launch site. The second stage would depart the DMCO Building for the Area 55 Second Stage Check-Out Building for verification of hydraulic and propulsion systems and destruct ordnance package installation. Both the first and second stages would then be transported to the launch pad for integration and testing. The GEM solid rocket motors would receive all prelaunch processing in Payload Hazardous Servicing Facility (PHSF) and Solid Motor Buildup Area 57 before being transported to the LC-17 launch pad and attached to the first stage. [MDA 1993]

2.1.5.2 Spacecraft Processing

2.1.5.2.1 Planetary Protection Requirements

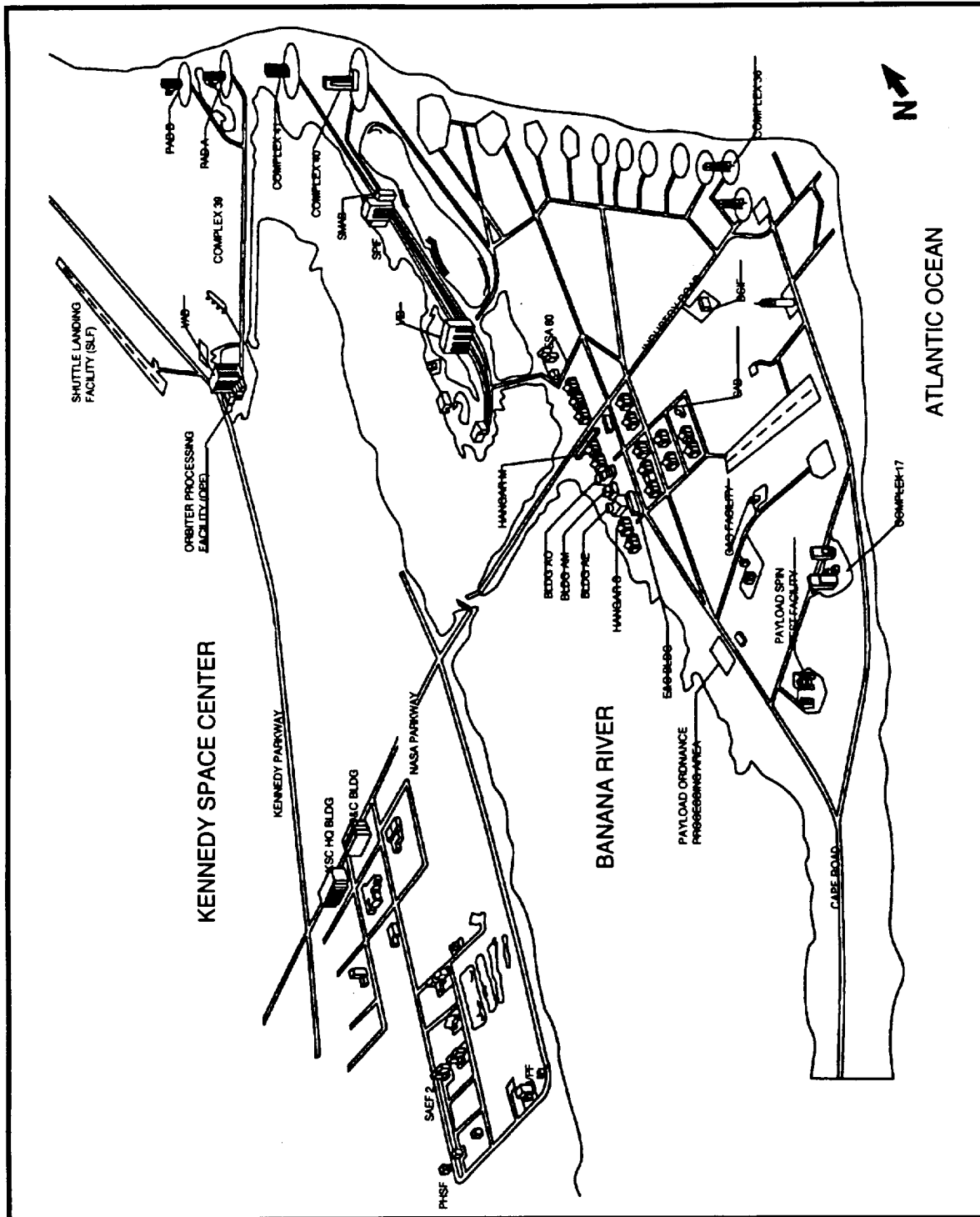
NASA follows established policy for the protection of planetary environments from contamination by spacecraft, and has obtained international acceptance of this policy through the Committee on Space Research of the International Council of Scientific Unions. NASA implements this policy by establishing planetary protection requirements for each applicable mission. The Space Studies Board of the National Research Council has recommended to NASA that spacecraft targeted to Mars without life-detection instrumentation be subject to assembly in an environment with no more than 100,000 particles greater than 5.0 microns in size per cubic foot (3,500 per liter) of air (Class 100,000 Clean Room) to reduce the potential organic contaminants. The MGS Project would comply with all planetary protection policies and requirements specified by NASA and would document compliance in the Mars Global Surveyor Planetary Protection Plan. [JPL 1995-C]

2.1.5.2.2 Spacecraft Component Assembly and Test Operations

The MGS main spacecraft buss would be transported via escorted surface carrier from Lockheed Martin to KSC incased in the reusable Topex shipping container. The solar panels, batteries, and thermal blankets would be transferred under escort separately in an air-ride moving van. All spacecraft parts would arrive at KSC for final assembly in mid-August 1996. At KSC's PHSF, the component systems and subsystems would undergo testing to verify proper operation prior to loading of the spacecraft propellant tanks. The spacecraft would then be mated to the PAM-D upper stage. This work is performed at KSC because the requisite facilities to perform these tasks are not available at CCAS. The following major component assembly activities would occur in the PHSF:

- Electronic ground support equipment check-out
- System test complex check-out
- Spacecraft baseline test to ensure that power, telemetry, science systems, etc., were not damaged in shipping
- Spacecraft propellant loading
- Spacecraft ordnance installation and check-out
- Spacecraft mating with the PAM-D third stage

In mid-October 1996, the spacecraft and upper stage would be transferred to CCAS LC-17 via the McDonnell Douglas Payload Transport Trailer, mated to the Delta launch vehicle, and final integrated tests with the launch vehicle would be conducted in preparation for the November 1996 launch.



Source: [USAF 1990]

Figure 2-6. Launch Vehicle and Spacecraft Processing Areas, KSC/CCAS

2.1.5.2.3 Pad Activities [JPL 1995-D]

The spacecraft would arrive at the base of the pad, be hoisted to the top of the launch tower payload level, and mated to the launch vehicle. Once mated to the launch vehicle, interface verifications with the launch vehicle, launch rehearsals, and power on/off stray voltage checks would be performed to verify spacecraft compatibility with the launch vehicle.

Integrated operations at the pad would also include:

- The PAM-D upper stage/spacecraft structure would be electrically mated to the Delta II 7925 launch vehicle.
- Final spacecraft functional tests would be performed.

2.2 ALTERNATIVES TO THE PROPOSED ACTION

Alternatives to the proposed action that were considered included those that: (1) utilize an alternate launch vehicle/upper stage combination, and (2) cancel the MGS mission (the No-Action alternative).

2.2.1 ALTERNATE LAUNCH SYSTEMS

2.2.1.1 Selection Criteria

Selecting a launch vehicle/upper stage combination (launch system) for a planetary mission largely depends on matching the payload mass and the energy required to achieve the desired trajectory to the capabilities of the prospective launch system. The more massive the payload and the more energy required to achieve the trajectory, the more powerful the launch system required. The most desirable launch system would meet, but would not greatly exceed, the mission's minimum launch performance requirements.

For the MGS mission, constraints on launch system performance are the MGS launch mass of approximately 1,060 kg (2,332 lb) and an injection energy (C_3) of $10.2 \text{ km}^2/\text{s}^2$ ($4 \text{ mi}^2/\text{s}^2$). [JPL 1995-A] Other considerations which must be addressed in selection of the launch system include reliability, cost, and potential environmental impacts associated with use of the launch system.

Feasible alternative MGS launch systems are potentially available from both foreign and domestic manufacturers. Potential alternative launch systems from foreign manufacturers include the European Space Agency (ESA) Ariane and the Russian Proton. Potential alternative U.S. launch systems include the Space Transportation System (STS) and various Atlas, Delta, and Titan configurations. [JPL 1993]

2.2.1.2 Foreign Launch Systems

Of the foreign launch systems that are potentially available for the Mars Global Surveyor mission, the ESA Ariane 44L and the Russian Proton most closely match the MGS requirements for performance and injection energy. However, both of these vehicles exceed by a wide margin the MGS mission requirements. Therefore, these foreign launch systems are not considered to be reasonable alternatives. Additionally, current U.S. government policy prohibits the launch of U.S. government-sponsored spacecraft on foreign launch systems.

2.2.1.3 U.S. Launch Systems

2.2.1.3.1 Space Transportation System

The STS greatly exceeds the Mars Global Surveyor mission requirements and would not be considered a reasonable alternative launch system.

2.2.1.3.2 U.S. Expendable Launch Systems

Potential alternative U.S. expendable launch systems include the Titan IIG/Star 48, Delta II 7325/Star 48, Titan IIS/Star 48, Delta II 7925/PAM-D, and Atlas I/Centaur.

- Neither the Titan IIG/Star 48 nor the Delta II 7325/Star 48 meet the minimum mass performance criteria, and are not considered as reasonable alternatives.
- The Titan IIS/Star 48 would potentially meet the mass and C_3 performance criteria, but the Titan IIS is only in the conceptual stage, and further development would be contingent upon Lockheed Martin proposal and selection for NASA's Intermediate Expendable Launch Vehicle (IELV) contract. The level of schedule and performance risk associated with this launch system at this time make it an undesirable alternative.
- Both the Delta II 7925/PAM-D and the Atlas I/Centaur launch systems meet the minimum Mars Global Surveyor mission requirements. However, the Delta II 7925/PAM-D system costs approximately 25 million (FY '92) dollars less than the Atlas I/Centaur and has a higher reliability than the Atlas I launch system.

2.2.1.4 Summary

Of the launch systems examined, the Delta II 7925/PAM-D combination is the best-suited for the Mars Global Surveyor mission, for the reasons listed below:

- The mass performance of the Delta II 7925/PAM-D most closely matches the MGS performance requirement. [JPL 1993]
- The Delta II 7925/PAM-D is the more reliable alternative launch system of those systems meeting the MGS performance criteria.
- The Delta II 7925/PAM-D is the lower cost alternative launch system of those systems meeting the performance criteria. [JPL 1993]
- Of the reasonable alternative launch systems examined, all were approximately equal in their potential environmental impacts. [DOT 1986]

2.2.2 NO-ACTION ALTERNATIVE

The No-Action alternative would result in termination of the mission, which would disrupt the progress of NASA's Inner Solar System Exploration Program. For Mars, the Program calls for progressively more detailed reconnaissance by spacecraft and robotic explorers. The No-Action alternative would delay or prevent the demonstration of technologies critical to future exploration of Mars. While minimal environmental impacts would be avoided by cancellation of the single launch, the loss of the scientific knowledge and database that could lead to future technological advances would be significant.

SECTION 3

GENERAL ENVIRONMENTAL CHARACTERISTICS OF CAPE CANAVERAL AIR STATION AND SURROUNDING AREA

The information provided in this section is summarized from the reference documents cited in the text. Refer to those references for more complete information and maps of environmental resources.

3.1 REGIONAL AND LOCAL ENVIRONMENT

For the purposes of this document, the region of interest (Figure 3-1) consists of the six county area of Volusia, Seminole, Lake, Orange, Osceola, and Brevard counties.

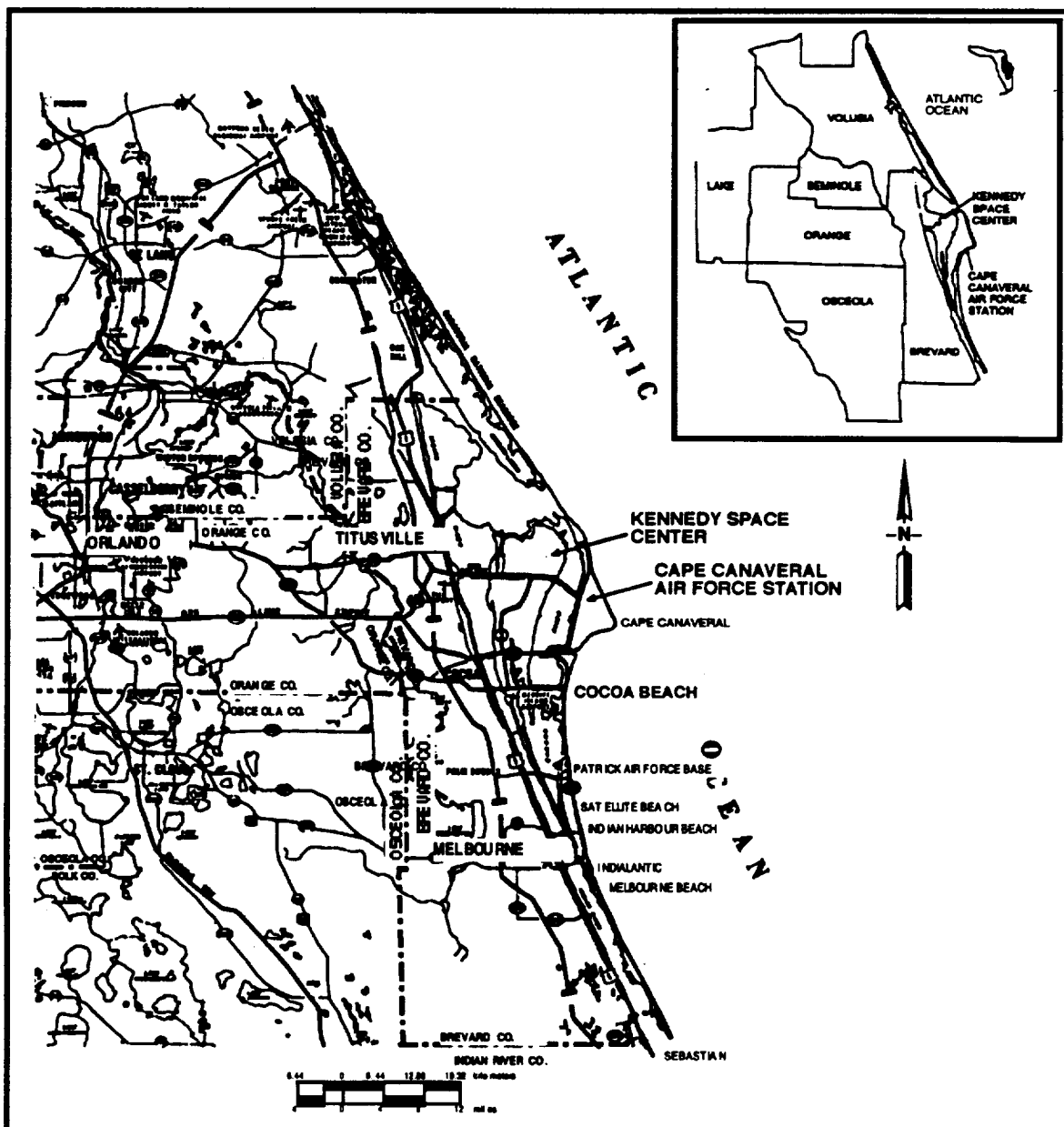
The Cape Canaveral Air Station is located in Brevard County on the eastern coast of Florida, near the city of Cocoa Beach and 75 km (45 mi) east of Orlando. The station occupies nearly 65 square (sq) km (25 sq mi) of the barrier island that contains Cape Canaveral, and is adjacent to the NASA Kennedy Space Center, Merritt Island, Florida. CCAS is bounded by KSC on the north, the Atlantic Ocean on the east, the city of Cape Canaveral on the south, and the Banana River and KSC/Merritt Island National Wildlife refuge on the west (Figure 3-2).

3.1.1 POPULATION DISTRIBUTION

For the last forty years, the population and economy of Brevard County has been closely linked to the growth of the space program. There was a constant influx of aerospace contractors and military personnel from the early 1950s through the mid-1960s. Employment levels dropped in the late-1960s, however, reflecting major cutbacks in NASA operations. The local aerospace economy recovered after 1979 due to a renewed national emphasis on launch activities.

CCAS employs approximately 11,700 people, but has no permanent residents. About 95 percent of the installation's military and civilian contractor personnel live in Brevard County, with the remainder residing in the surrounding counties. Major population centers includes Titusville (20 km [12 mi] northwest), Cocoa Beach (13 km [8 mi] south), Cocoa (12 km [7 mi] southwest), and Cape Canaveral (0.8 km [0.5 mi] south). All military personnel serving at the station are assigned to Patrick Air Force Base (PAFB), about 25 km (15 mi) to the south of CCAS. [USAF 1990]

The population growth rate for Brevard County has been projected at 3.2 percent annually through 1995; this would imply a population of about 473,000 by that year. The greatest increase is expected to occur in southern Brevard County and the lowest in the central portion of the county. [USAF 1990] In February 1990, Brevard County's civilian labor force was 178,359 and the unemployment rate was 5.4 percent. The employment base for the region consists primarily of manufacturing, retail trade, services (with an emphasis on tourism), and



Source: [NASA 1986]

Figure 3-1. Regional Area of Interest

government-related enterprises. Brevard County workers received a total personal income of nearly \$5.5 billion in 1987, which translates to a per capita income of \$14,650. [USAF 1991]

3.1.2 LAND USE

Only about 8 percent, or 1,327.42 sq km (510 sq mi), of the total region (17,000 sq km; 6,534.8 sq mi) is urbanized [ECFRPC 1992], with the largest concentrations of people occurring in three metropolitan areas:

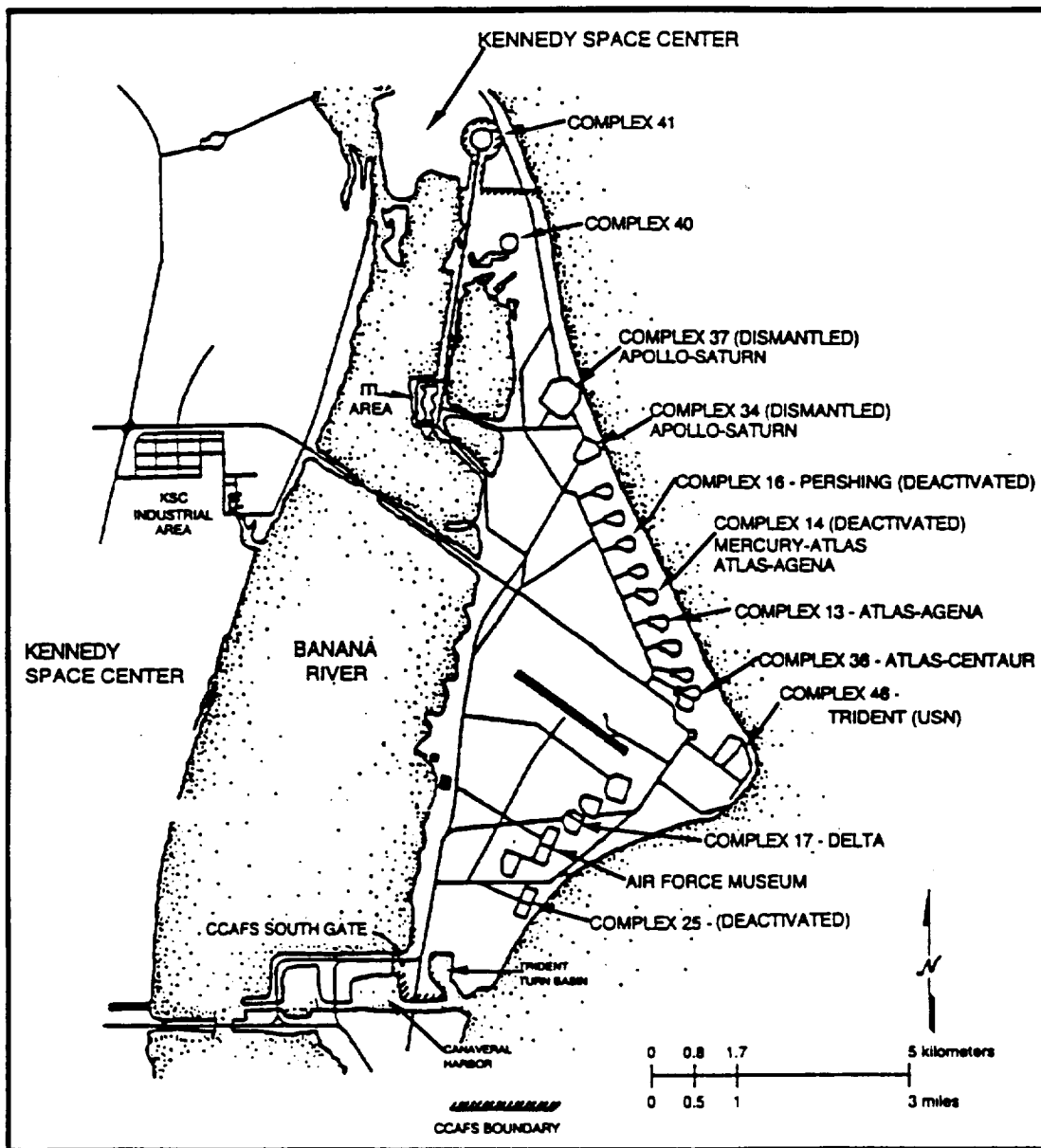
- Orlando, in Orange County, expanding into the Lake Mary and Sanford areas of Seminole County to the north, and into the Kissimmee and St. Cloud areas of Osceola County to the south,
- the coastal area of Volusia County, including Daytona Beach, Port Orange, Ormond Beach, and New Smyrna Beach, and
- along the Indian River Lagoon and coastal areas of Brevard County, specifically the cities of Titusville, Melbourne, and Palm Bay.

Approximately 85 percent of the region's population lives in urban areas.

The majority of the region is considered rural, which includes agricultural lands and their associated trade and service areas, conservation and recreation lands, and undeveloped areas. About 35 percent of the regional area is devoted to agriculture, including more than 5,000 farms, nurseries, and ranches. Agricultural areas include citrus groves, winter vegetable farms, pasture land and livestock, foliage nurseries, sod farms, and dairy land.

In Brevard County, approximately 68 percent of the developed land use is agricultural, 12 percent is residential, 2 percent is commercial, 1 percent industrial, and 1 percent institutional. The remaining 16 percent is comprised of various other uses. The developed land areas are clustered in three areas in a north-south pattern along the coast and the banks of the Indian and Banana Rivers. [USAF 1990]

Approximately 30 percent of the CCAS (about 18.8 sq km; 7.3 sq mi) is developed, and consists of launch complexes and support facilities (Figure 3-3). The remaining 70 percent is comprised of unimproved land. The CCAS also contains a small industrial area, the Air Force Space Museum, a turning basin for the docking of submarines, and an airstrip that was initially constructed for research and development in recovery operations for missile launches. Many of the hangars located on the station are used for missile assembly and testing. Future land use patterns are expected to remain similar to current conditions. The Kennedy Space Center occupies almost 560 sq km (about 216 sq mi), about 5 percent of which is developed land. Nearly 40 percent of the KSC consists of open water areas, such as portions of the Indian and Banana Rivers, Mosquito Lagoon, and all of Banana Creek. [USAF 1990]



Source: [USAF 1986]

Figure 3-3. Land Use at CCAS

LC-17 (Figure 3-4) is located in the southern portion of the CCAS, approximately 0.8 km (0.5 mi) west of the Atlantic Ocean, 2.5 km (1.5 mi) east of the Banana River, and roughly 5.7 km (3.4 mi) from the station's South Gate. The complex consists of two launch pads, 17A and 17B, each with its own mobile Missile Service Tower, Fixed Umbilical Tower, cable runs, and Fuel Storage Area. [USAF 1990]

A concrete exhaust flume on each pad deflects exhaust gases away from the pad to reduce the noise and shock wave that result from ignition of solid rockets and the first stage of the launch vehicle. The noise levels of a Delta II 7925/PAM-D launch do not require a water deluge system acoustic mitigation measure. [JPL 1995-E]

The two launch pads share common gas storage facilities, located in bunkers between the pads, and are monitored from a common blockhouse, located at a distance from the launch pads. Other miscellaneous support and service facilities are shared between them, as well. LC-17 was renovated in the late 1980s to support an upgraded version of the Delta launch vehicle.

3.1.3 ECONOMIC BASE [NASA 1990]

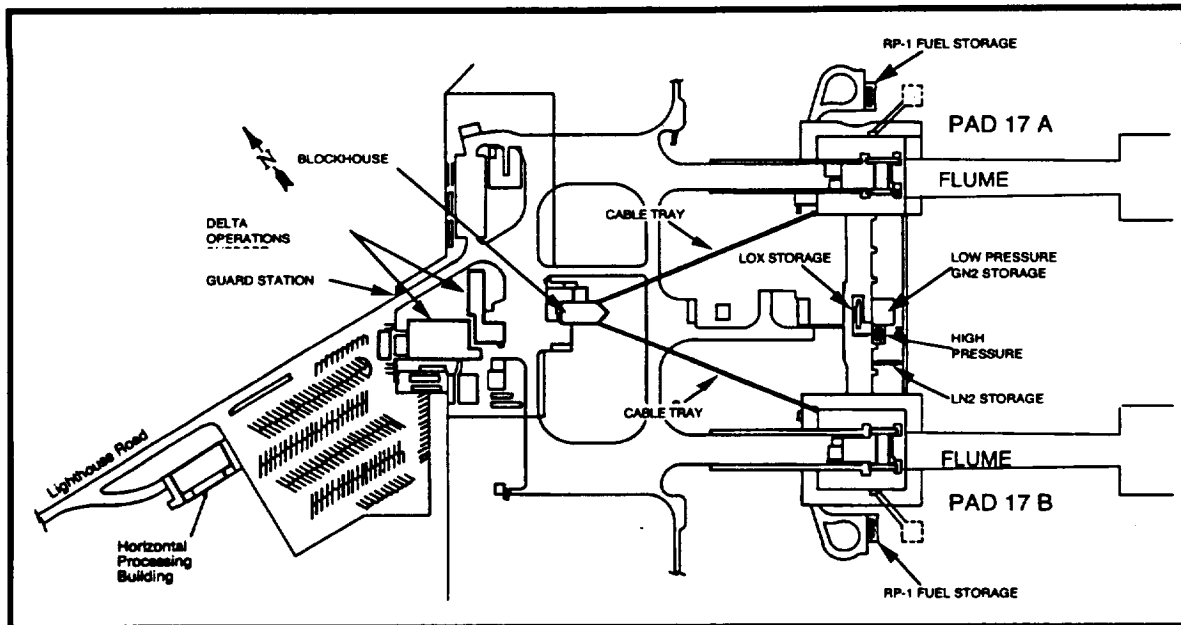
The region's economic base is tourism and manufacturing. Tourism-related employment includes most jobs in amusement parks, hotels, motels, and campgrounds, as well as many occupations in the retail trade and various types of services. Manufacturing jobs, while probably outnumbered by tourism jobs, may provide more monetary benefits to the region because of higher average wages and a larger multiplier effect.

The region's agricultural activities include citrus groves, winter vegetable farms, pastures, foliage nurseries, sod, livestock, and dairy production. In the central region, 30 percent of the land is forested and supports silviculture, including harvesting of yellow pine, cypress, sweetgum, maple, and bay trees. In Osceola County, large cattle ranches occupy almost all of the rural land. Agricultural employment declined in 1986 to just 2.2 percent of the region's employment base.

Commercial fisheries in the two counties bordering the ocean (Brevard and Volusia) landed a total of approximately 9,727 metric tons (about 21.4 million pounds) of finfish, shrimp and other invertebrates in 1988. Brevard and Volusia Counties ranked third and fourth, respectively, among the East Coast counties of Florida in total 1988 finfish landings.

3.1.4 PUBLIC FACILITIES AND EMERGENCY SERVICES [USAF 1990]

The city of Cocoa provides potable water, drawn from the Floridan Aquifer, to the central portion of Brevard County. The maximum capacity is 152 million liters (40 million gallons [gal]) per day, and average daily consumption is about 99 million l (26 million gal) per day.



Source: [USAF 1988]

Figure 3-4. Launch Complex 17

The cities of Cocoa, Cape Canaveral, Cocoa Beach, and Rockledge are each served by their own municipal sewer systems. Unincorporated areas are accommodated by several plants, some of which have reached capacity. Municipal plants in Cape Canaveral, Cocoa Beach, and Cocoa have been expanded and plans are in the works for expansion of the Rockledge system.

Florida Power and Light supplies electricity to Brevard County. Police departments in the five municipalities of the central Brevard area have an average of one officer per 631 people, and fire protection has one full-time officer per 936 people. Health care within the area is available at 28 general hospitals, three psychiatric hospitals, and two specialized hospitals.

Rail transportation for Brevard County is provided by Florida East Coast Railway. A main line traverses the cities of Titusville, Cocoa, and Melbourne, and spur lines provide access to other parts of the county. [USAF 1986]

3.1.5 CCAS FACILITIES AND SERVICES

CCAS receives its water supply from the city of Cocoa, and uses roughly 11.4 million l (3 million gal) per day. To support launch facility deluge systems, the distribution system at CCAS was constructed to provide up to 114,000 l (30,000 gal) per minute for up to ten minutes. [USAF 1990]

The CCAS provides for its own sewage disposal with on-site package sewage treatment plants (STPs). The LC-17 STP has a capacity of 57,000 l (15,000 gal) per day and is permitted by the Florida Department of Environmental Protection (FDEP). [USAF 1988] Current CCAS plans call for a consolidated Waste Water Treatment Plant (WWTP) to be operational in late 1996. [JPL 1995-A]

All nonhazardous solid waste goes to the Brevard County Landfill. Hazardous wastes are accumulated at a number of locations throughout CCAS pending disposal. Wastes are collected for up to 90 days at the accumulation sites before transfer to one of three CCAS hazardous waste storage facilities, where they are stored for eventual shipment to a licensed hazardous waste treatment/disposal facility. [USAF 1986] CCAS has a Resource Conservation and Recovery Act (RCRA) permitted Explosive Ordnance Disposal (EOD) facility which supports disposal of CCAS- & KSC-generated wastes, such as shavings from SRMs. All hazardous wastes generated at CCAS are managed according to the CCAS Petroleum Products and Hazardous Waste Management Plan (OPlan 19-14).

To prevent oil or petroleum discharges into U.S. waters, a Spills Prevention, Control, and Countermeasures Plan (SPCCP) is required by the EPA's oil pollution prevention regulation. A SPCCP has been integrated into the CCAS Oil and Hazardous Substance Pollution Contingency Plan (OPlan 19-1). Spills of oil or petroleum products that are federally listed hazardous materials will be collected and removed for proper disposal by a certified contractor according to this plan. All spills/releases will be reported to the host installation per OPlan 19-1.

The Launch Base Support (LBS) Contractor conducts all police services on CCAS. A mutual agreement for fire protection services exists between the city of Cape Canaveral, KSC, and the LBS Contractor at CCAS. The station is equipped with a dispensary under contract to NASA. The dispensary normally works on a forty-hour week basis. If medical services cannot be provided by the dispensary, hospitals at PAFB and in Cocoa, Titusville, and Melbourne are used. [USAF 1986]

3.1.6 CULTURAL RESOURCES

Within the region, there are 81 sites that are listed in the National Register of Historic Places (NRHP) [DOI 1991], and 2 in the National Register of Historic Landmarks.

In 1982, an archeological/historical survey of CCAS was conducted that consisted of literature and background searches and field surveys. The survey located 32 prehistoric and historic sites and several uninvestigated historic localities. Results of the field survey indicated that many of the archeological resources had been severely damaged by the construction of roads, launch complexes, power lines, drainage ditches, and other excavation. The survey recommended 11 sites for further evaluation to determine eligibility for the NRHP. [RAI 1982] CCAS is a National Historic Landmark (NHL) District, and LC-17 has been identified as eligible for listing in the NRHP.

The protection and interpretation of significant resources associated with the space program are underway by the Department of Interior, National Park Service, and USAF, through the Man in Space National Historic Landmark Program. Areas at CCAS designated as landmark sites include the Mission Control Center and launch complexes 5, 6, 13, 14, 19, 26, and 34, which were used during the Mercury, Gemini, and early Apollo manned space flights. [USAF 1988] [45 AMDS/SGPB]

3.2 NATURAL ENVIRONMENT

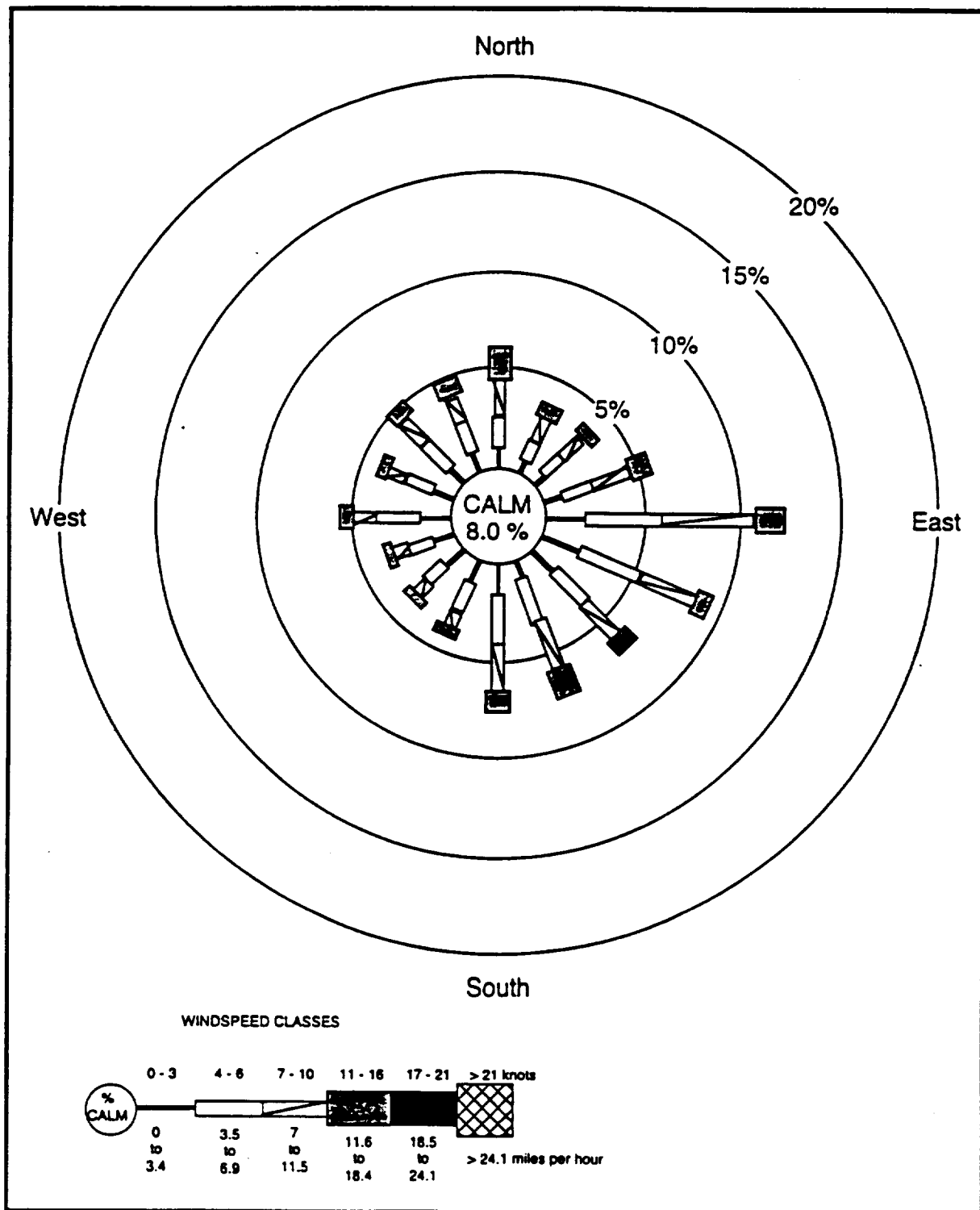
3.2.1 METEOROLOGY AND AIR QUALITY

3.2.1.1 Meteorology

The climate of the region is subtropical with two distinct seasons: long, warm, humid summers and short, mild, and dry winters. [NASA 1992] Rainfall amounts vary both seasonally and yearly. Average rainfall is 128 centimeters (cm) (51 inches[in]), with about 70 percent falling during the wet season (May to October). Temperature is less variable — prolonged cold spells and heat waves rarely occur. Tropical storms, tropical depressions, and hurricanes occasionally strike the region, generally in the period starting in August and ending in mid-November. The probability of winds reaching hurricane force in Brevard County in any given year is approximately 1 in 20. [USAF 1986] Tornadoes may occur, but are very scarce. Hail falls occasionally during thunderstorms, but hailstones are usually small and seldom cause much damage. Snow in the region is rare.

Summer weather typically lasts about nine months of the year, starting in April. Afternoon thundershowers are common and usually result in lower temperatures and an ocean breeze. Occasional cool days occur as early as November, but winter weather generally commences in January and extends through March. [NASA 1986]

The wind rose in Figure 3-5 shows the annual average frequency distribution of average wind speed and direction in the vicinity of CCAS. At CCAS, winds typically come from the north/northwest from December through February, from the southeast from March through May, and from the south from June through August. Sea breeze and land breeze phenomena occur commonly over any given 24-hour period due to unequal heating of the air over the land and ocean. Land breeze (toward the sea) occurs at night when air over land has cooled to a lower temperature than that over the sea; sea breeze (toward the land) occurs during the day when air temperatures over the water are lower. The sea breeze and land breeze phenomena occur frequently during the summer months, less frequently during the winter. [USAF 1986]



Source: [USAF 1990]

Figure 3-5. Wind Rose Indicating Wind Speed and Direction — Lower Atmospheric Conditions: Cape Canaveral 1968 - 1978 Annual Averages

3.2.1.2 Air Quality

Air quality at CCAS is considered good, primarily because of the distance of the station from major sources of pollution. There are no Class I or nonattainment areas for criteria pollutants (ozone [O₃], nitrogen oxides [NO_x], sulfur dioxide [SO₂], lead [Pb], carbon monoxide [CO], and particulates) within about 96 km (60 mi) of CCAS. Orange County was a nonattainment area for ozone until 1987, when it was redesignated as an ozone attainment maintenance area. [NASA 1992]

The station and its vicinity are considered to be "in attainment" or "unclassifiable" with respect to National Ambient Air Quality Standards (NAAQS) for criteria pollutants. [USAF 1990] The criteria pollutants and the federal and state standards are listed in Table 3-1. NAAQ primary and secondary standards apply to continuously emitting sources, while a launch is considered to be a one-time, short-term moving source; however, the standards will be used for comparative purposes throughout this EA to provide a reference, since no other more appropriate standards exist.

The daily air quality at CCAS is chiefly influenced by a combination of vehicle traffic, maintenance activities, utilities fuel combustion, and incinerator operations. Space launches influence air quality only episodically. Two regional power plants are located within 20 km (12 mi) of the station and are believed to be the primary source of occasional elevations in nitrogen dioxide and sulfur dioxide levels. Ozone has been CCAS's most consistently elevated pollutant. However, since January 1992, the primary standard for ozone has not been exceeded. [DC 1995]

3.2.2 NOISE

Monitoring of ambient noise levels at CCAS has not been performed. However, it would be expected that noise generated at the station would include sources from day-to-day operations, launches of space vehicles, industrial operations, construction, and vehicular traffic. [USAF 1990]

Day-to-day operations at CCAS would most likely approximate that of any urban industrial area, reaching levels of 60 to 80 decibels (dBA), but with a 24-hour average ambient noise level that is somewhat lower than the EPA-recommended upper level of 70 dBA. [USAF 1990], [NASA 1992]

Launches occur infrequently, but during liftoff launch vehicle rocket engine noise is characterized as intense, composed predominantly of low frequencies, and has a relatively short duration. This noise is usually perceived by the surrounding communities as a distant rumble. A concrete exhaust flume on each pad deflects exhaust gases away from the pad to reduce the noise and shock wave that result from ignition of solid rockets and the first stage of the launch vehicle. [USAF 1988, JPL 1995-E]

Table 3-1. State and Federal Air Quality Standards

Pollutant	Averaging Time	State of Florida Standard	Federal Primary Standard	Federal Secondary Standard
Carbon Monoxide (CO)	8-hour *	10 mg/m ³ (9 ppm)	10 mg/m ³ (9 ppm)	none
	1-hour *	40 mg/m ³ (35 ppm)	40 mg/m ³ (35 ppm)	none
Lead (Pb)	Quarterly Arithmetic Mean	1.5 µg/m ³	1.5 µg/m ³	same as primary
Nitrogen Dioxide (NO ₂)	Annual Arithmetic Mean	100 µg/m ³ (0.05 ppm)	100 µg/m ³ (0.05 ppm)	same as primary
Ozone (O ₃)	1-hour +	235 µg/m ³ (0.12 ppm)	235 µg/m ³ (0.12 ppm)	same as primary
Sulfur Dioxide (SO ₂)	Annual Arithmetic Mean	80 µg/m ³ (0.03 ppm)	80 µg/m ³ (0.03 ppm)	none
	24-hour *	260 µg/m ³ (0.1 ppm)	365 µg/m ³ (0.14 ppm)	none
	3-hour *	1300 µg/m ³ (0.5 ppm)		1300 µg/m ³ (0.5 ppm)
Particulate Matter 10 (PM10)	Annual Arithmetic Mean		50 µg/m ³	same as primary
	24-hour *		150 µg/m ³	same as primary

Source: [NASA 1992]

NOTE: mg/m³ = milligrams per cubic meter

µg/m³ = micrograms per cubic meter

ppm = parts per million

* Not to be exceeded more than once per year

+ Not to be exceeded an average of more than one day per year over a three-year period

Space launches also generate sonic booms during vehicle ascent and stage reentry. Launch-generated sonic booms are directed upward and in front of the vehicle and occur over the Atlantic Ocean. Stage reentry sonic booms also occur over the open ocean and do not impact developed coastal areas. [USAF 1990] Some launch vehicle related noise levels measured at KSC are shown in Table 3-2.

Peak noise levels created by industrial and construction activities — mechanical equipment, such as diesel locomotives, cranes, and rail cars — could range from about 90 to 111 dBA. Vehicular traffic noise ranges from around 85 dBA for a passenger auto to about 100 dBA for a motorcycle. [NASA 1992]

Table 3-2. Launch Noise Levels at Kennedy Space Center

SOURCE	NOISE LEVEL	REMARKS
Titan IIIC	93.7 dBA	21 October 1965
Saturn I	89.2 dBA	Average of 3 launches
Saturn V	91.0 dBA	15 April 1969
Space Shuttle	89.6 dBA	Estimated

Source: [NASA 1992]

3.2.3 LAND RESOURCES

3.2.3.1 Geology

The region is underlain by a series of limestone formations, with a total thickness of several thousand feet. The lower formations contain the Upper Floridan Aquifer, which is under artesian pressure in the vicinity of the station. At CCAS, the Upper Floridan Aquifer commences at a depth of about 80 m (260 ft) and is about 110 m (360 ft) thick. [USAF 1990] Beds of sandy clay, shells, and clays of the Hawthorn formation overlay the Floridan Aquifer, isolating the Floridan Aquifer from other, more shallow aquifers. The Hawthorn formation lies at a depth of about 30 m (100 ft) at CCAS and is about 50 m (160 ft) thick. Overlying the Hawthorne formation are upper Miocene, Pliocene, Pleistocene, and recent age deposits, which form secondary, semi-confined aquifers and the Surficial Aquifer, which lay at depths up to about 30 m (100 ft).

CCAS lies on a barrier island composed of relict beach ridges formed by wind and wave action. This island, approximately 7.5 km (4.5 mi) wide at the widest point, parallels the Florida shoreline and separates the Atlantic Ocean from the Indian River, Indian River Lagoon, and Banana River. The land surface elevation ranges from sea level to about 6 meters (20 ft) above sea level at its highest point. LC-17 is located near the southeastern shore of the station. This area is designated as above the 500-year floodplain. [USAF 1990]

3.2.3.2 Soils

Soils on CCAS have been mapped by the U.S. Department of Agriculture Soil Conservation Service (SCS). Soil types that have been identified by the SCS in the vicinity of LC-17 are Canaveral Complex, Palm Beach Sand, Urban Land, and Canaveral-Urban Land Complex. These native soils are composed of highly permeable, fine-grained sediments typical of beach and dune deposits. Based on examination of well and soil borings from CCAS, the near-surface stratigraphy is fairly uniform, consisting of Pleistocene age sand deposits that underlie the installation to depths of approximately 30 m (100 ft). [USAF 1988]

3.2.4 HYDROLOGY AND WATER QUALITY

3.2.4.1 Surface Waters

The station is located on a barrier island that separates the Banana River from the Atlantic Ocean. As is typical of barrier islands, the drainage divide is the dune line just inland from the ocean. Little runoff is naturally conveyed toward the ocean; most runoff percolates or flows westward toward the Banana River. The majority of storm drainage from CCAS is collected in manmade ditches and canals and is directed toward the Banana River.

Major inland water bodies in the CCAS area are the Indian River, Banana River, and Mosquito Lagoon. These water bodies tend to be shallow except for those areas maintained as part of the Intracoastal Waterway. The Indian and Banana Rivers connect adjacent to Port Canaveral by the Barge Canal, which bisects Merritt Island; they have a combined area of 600 sq km (2.32 sq mi) in Brevard County and an average depth of 1.8 m (6 ft). This area receives drainage from 2,160 sq km (834 sq mi) of surrounding terrain.

Predominant ocean currents in the vicinity of CCAS are north of the area. From the Cape Canaveral region to 26 km (16 mi) offshore, the average ocean current speed is 1.7 to 5 km per hour (1 to 3 mi per hour). Beyond about 26 km, the system of currents becomes known as the Florida Current of the Gulf Stream. The central axis of the Gulf Stream is located approximately 83 km (50 mi) off the coast of Florida at Cape Canaveral.

3.2.4.2 Surface Water Quality

Surface water quality near CCAS and KSC is monitored at 11 long-term monitoring stations that are maintained by NASA. It is also monitored by the Air Force Bioenvironmental Engineering Services on a quarterly basis at 7 sites. Other monitoring stations in the general area are maintained by Brevard County, the U.S. Fish and Wildlife Service, and the FDEP. [NASA 1992] In general, the water quality in the monitored surface waters has been characterized as good. Both the northern and southern segments of the Banana River tend to be brackish to saline (15 to 36 parts per thousand [ppt]) at NASA Causeway East. [USAF 1990] Water quality monitoring data for the southern segment of the Banana River is summarized in Table 3-3.

The Banana River is designated a Class III surface water, as described by the Federal Clean Water Act of 1977. Class III standards are intended to maintain a level of water quality suitable for recreation and the production of fish and wildlife communities.

The Banana River is also designated an Outstanding Florida Water (OFW) by the Florida Department of Environmental Protection. An OFW is provided the highest degree of protection of any Florida surface waters. [NASA 1992]

Table 3-3. Summary of Water Quality Monitoring Data for South Banana River

Parameter	Average Value	Range of Values	State FDEP Class III Standards
Conductivity ($\mu\text{mhos/cm}$)	33,300	12,470 - 50,500	Varies
Total Suspended Solids (mg/l)	32	1 - 143	No standard
Turbidity NTU	2.09	0.76 - 5.0	29 NTU above background
Oil and Grease (mg/l)	0.8	<0.2 - 3.9	≤ 5.0 ; no taste or odor
Phenols ($\mu\text{g/l}$)	128	32 - 364	< 300
Alkalinity (mg/l)	130	109 - 168	≥ 20 (fresh water)
pH	8.6	7.4 - 9.2	6.5 - 8.5 (marine water)
Total Kjeldahl Nitrogen (mg/l)	1.96	0.23 - 15.00	No standard
Nitrate Nitrogen (mg/l)	0.02	<0.02 - 0.06	No standard
Ortho Phosphate (mg/l)	0.032	<0.025 - 0.08	No standard (marine)
Chlorophyll A (mg/m^3)	5.0	<0.5 - 74.7	No standard
Biological Oxygen Demand (mg/l)	2.5	<1 - 7	No standard
Chemical Oxygen Demand (mg/l)	712	478 - 1361	No standard
Dissolved Oxygen (mg/l)	6.6	2.1 - 10.2	≥ 4 mg/l (marine water)
Total Organic Carbons (mg/l)	5.41	2.23 - 13.00	No standard
Aluminum (mg/l)	0.62	< 0.10 - 8.47	≤ 1.5 (marine water)
Cadmium ($\mu\text{g/l}$)	0.56	<0.01 - 2.86	≤ 0.3
Chromium (mg/l)	0.020	<0.001 - 0.05	0.5 (Cr^{+6})
Iron (mg/l)	0.075	<0.040 - 0.178	0.3 (marine water)
Zinc (mg/l)	0.023	< 0.01 - 0.234	86 (fresh water)
Silver ($\mu\text{g/l}$)	17.88	< 0.05 - 31.3	≤ 0.05 (marine water)

Source: [NASA 1992]

NOTE: mg/l = milligram per liter
 $\mu\text{g/l}$ = microgram per liter
 $\mu\text{mhos/cm}$ = micromhos per centimeter

3.2.4.3 Ground Waters [USAF 1988]

Ground water at the station occurs under both confined (artesian) and unconfined (nonartesian) conditions. Confined ground water is located in the Floridan Aquifer, which serves as the primary ground water source in the coastal lowlands. Recharge to the Floridan Aquifer occurs primarily in northern and central Florida.

Although good quality water may be obtained from the Floridan Aquifer throughout much of the state, water from this formation on CCAS is highly mineralized and is not used for domestic or commercial purposes. Water for domestic and commercial purposes in this area is generally retrieved from the shallow, unconfined aquifer.

This unconfined surficial aquifer, or water table, is composed of recent and Pleistocene age surface deposits, and is usually found up to 1.5 m (5 ft) or so below land surface. It is recharged by rainfall along the coastal ridges and dunes. The unconfined aquifer formation at CCAS ranges in depth from about 15 m (50 ft) at the coastal ridge to less than 6 m (20 ft) in the

vicinity of the St. Johns River. The unconfined aquifer beneath LC-17 is not used as a water source.

3.2.4.4 Ground Water Quality

Ground water of the Floridan Aquifer at CCAS is not used as a domestic or commercial water source. Table 3-4 summarizes the water quality characteristics of a sample collected from the Floridan Aquifer underlying the west-central portion of the station. The sample exceeded national drinking water standards for sodium, chloride, and total dissolved solids (TDS). [NASA 1992]

Overall, water in the unconfined aquifer in the vicinity of KSC and CCAS is of good quality and meets the State of Florida Class G-II (suitable for potable water use; total dissolved solids less than 10,000 milligrams per liter [mg/l]) and national drinking water quality standards for all parameters, with the exception of iron, and/or total dissolved solids. [NASA 1992], [USAF 1990] There are no potable water wells located at LC-17 or in its vicinity.

Table 3-4. Ground Water Quality for the Floridan Aquifer at CCAS

Parameter	Average Value (mg/l)	Drinking Water Standards (mg/l)
Nitrates (as Nitrogen)	< 0.01	10 (primary standard)
Chlorides	540	250 (secondary standard)
Copper	<0.01	1.0 (secondary standard)
Iron	0.02	0.3 (secondary standard)
Manganese	<0.001	0.05 (secondary standard)
Sodium	1400	160 (primary standard)
Sulfate	85	250 (secondary standard)
Total Dissolved Solids	1,425	250 (secondary standard)
pH	7.6	6.5 - 8.5 (secondary standard)
Zinc	<0.01	5.0 (secondary standard)
Arsenic	<0.01	0.05 (primary standard)
Barium	0.02	1.0 (primary standard)
Cadmium	<0.001	0.01 (primary standard)
Chromium	0.001	0.05 (primary standard)
Lead	<0.001	0.05 (primary standard)
Mercury	0.0005	0.002 (primary standard)
Selenium	0.006	0.01 (primary standard)

Source: [USAF 1988]

NOTE: mg/l = milligrams per liter

primary standard = National Interim Primary Drinking Water Regulations

secondary standard = National Secondary Drinking Water Regulations

Ground water quality in five monitoring wells at LC-17 is generally good, with some detectable quantities of trace metals and organic compounds reported in one well, and detectable zinc concentrations in another. [MDC 1990] These results suggest that soil contaminants

detected by earlier studies [USAF 1988] may be relatively non-mobile under the present soil conditions.

3.2.5 BIOTIC RESOURCES

The station is located in east-central Florida on the Cape Canaveral peninsula. Ecological resources at CCAS are influenced by the Atlantic Ocean on the east and the Banana River on the west. Vegetation communities and related wildlife habitats are representative of barrier island resources of the region. Major community types at CCAS include beach, coastal strand and dunes, coastal scrub, lagoons, brackish marsh, and freshwater systems in the form of canals and borrow pits.

The restrictive nature of CCAS and KSC activities has allowed large areas of land to remain relatively undisturbed. In addition to communities found at CCAS, coastal hammocks and pine flatwoods are found on KSC to the northwest and increase the ecological diversity and richness of the area. [USAF 1988] A majority of the 65 sq km (25 sq mi) complex consists of coastal scrub, woodland, strand, and dune vegetation. Coastal scrub and coastal woodland provide excellent cover for resident wildlife. Coastal strand occurs immediately inland of the coastal dunes and is composed of dense, woody shrubs. Coastal dune vegetation (a single layer of grass, herbs, and dwarf shrubs) exists from the high tide point to between the primary and secondary dune crest. Wetlands represent only a minor percentage (less than 4 percent) of the total land area and include freshwater marsh, mangrove swamp, and salt swamp. Known hammocks are small, total less than 0.8 sq km (0.3 sq mi), and are characterized by closed canopies of tree, shrub, and herb vegetation. Most of the wildlife species resident at the station can be found in each of these vegetation communities. No federally designated threatened or endangered flora are known to exist at CCAS. [USAF 1991]

3.2.5.1 Terrestrial Biota [USAF 1988]

Natural upland vegetation communities found on CCAS are coastal dune, coastal strand, coastal scrub, and hammock. Wetlands found on-site include both marshes and swamps.

The coastal dune community extends from the coastal strand system to the high tide line. Dune systems develop on poorly consolidated, excessively drained sands that are exposed to constant winds and salt spray.

LC-17 is surrounded by coastal scrub vegetation. The coastal scrub community covers approximately 37.6 sq km (14.5 sq mi), or about 78 percent of the undeveloped land on CCAS. This community is distributed on excessively drained, nutrient-deficient marine sands.

Coastal strand vegetation occurs between the coastal dune and scrub communities and lies just east of LC-17. Coastal strand communities exist on sandy, excessively drained soils dominated by shrubs and often are nearly devoid of ground cover vegetation.

CCAS beaches are nonvegetated, but provide significant wildlife resources. The tidal zone supports a large number of marine invertebrates, as well as small fish that are food for various shorebirds. CCAS and KSC beaches are also important nesting areas for several varieties of sea turtles.

Coastal hammocks are characterized by closed canopies of cabbage palm. Hammocks are shaded from intense insolation, and therefore retain higher levels of soil moisture than the previously described habitats. No hammocks occur in the immediate vicinity of LC-17, the nearest one being about 3 km (1.8 mi) west of the site, adjacent to the Banana River.

Wetlands within CCAS and surrounding station facilities are important wildlife resources. Wetland types that are found in the area include fresh water ponds and canals, brackish impoundments, tidal lagoons, bays, rivers, vegetated marshes, and mangrove swamps. No marsh or swamp systems occur near LC-17. The nearest wetland environment is a saltwater marsh/swamp on the northwestern shore of Merritt Island, 8.2 km (about 5 mi) north of the launch complex. These soils are not suitable for cultivation, yet do contain swamp plants that support migratory and wading birds. [USAF 1990]

Species of plant and animal life observed or likely to occur on CCAS are listed in reference USAF 1988.

3.2.5.2 Aquatic Biota [USAF 1988]

The northern Indian River lagoon ecosystem is a shallow system with limited ocean access, limited tidal flux, and generally mesohaline salinities. The aquatic environment is subject to wide fluctuations in temperature and salinity due to the shallowness of the system.

Sea grasses are present in the Indian River system, generally found in patches in shoal areas less than 1 m (3 ft) deep and surrounded by open, sandy terrain. Benthic invertebrates found in the northern Indian and Banana Rivers include marine worms, mollusks, and crustaceans, typical of estuarine systems. Epibenthic invertebrates collected from the area included horseshoe crabs, blue crabs, and penaid shrimp.

The area is not considered an important nursery area for commercially important shrimp species. Mosquito Lagoon, north of the complex, has been considered an important shrimp nursery area. Blue crabs were determined to spawn in the area.

Few freshwater fish species inhabit the area. Many of the area's freshwater fish species are believed to have been introduced by man. Primary reasons for the low diversity in fish species are considered to be latitude, climate, low habitat diversity, and limited ocean access.

3.2.5.3 Threatened and Endangered Species

The U.S. Fish and Wildlife Service (FWS), the Florida Game and Fresh Water Fish Commission (FGFWFC), and the Florida Commission on Rare and Endangered Plants and Animals (FCREPA) protect a number of wildlife species listed as endangered or threatened under Federal or State of Florida law. The presence, or potential for occurrence, of such species on CCAS was determined from consultations with FWS, FGFWFC, and CCAS and KSC environmental staff, and from a literature survey. Table 3-5 lists those endangered or threatened species in Brevard County residing or seasonally occurring on CCAS and adjoining waters.

A review of the list indicates that only three species (southeastern kestrel, Florida scrub jay, and eastern indigo snake) potentially occur in the immediate vicinity of LC-17. Three additional species may occasionally occur in wetlands on CCAS. West Indian manatees, green turtles, and loggerhead turtles are known to occur in the Banana River, Mosquito Lagoon, and along Atlantic Ocean beaches. The red-cockaded woodpecker is not known to occur in the vicinity of LC-17.

Table 3-5. Listed and Proposed Threatened and Endangered Animal Species and Candidate Animal Species In Brevard County and Their Status On CCAS

SPECIES ^a	STATUS ^b			CAPE CANAVERAL
	USFWS	FGFWFC	FCREP A	AIR STATION ^c
Atlantic Loggerhead Sea Turtle	T	T	T	Occurs on beach/nests
Green Sea Turtle	E	E	E	Occurs on beach/nests
Leatherback Sea Turtle	E	E	R	Rare nesters
Hawksbill Sea Turtle	E	E	E	Occurs offshore/no nests
Eastern Indigo Snake	T	T	SSC	Resident
American Alligator	T(S/A)	SSC	SSC	Resident
Atlantic Salt Marsh Snake	T	T	E	Not observed
Gopher Tortoise	T	SSC	T	Resident
Florida Scrub Jay	T	T	T	Resident
Wood Stork	E	E	E	Resident
Southern Bald Eagle	E	T	T	Visitor
Piping Plover	E	T	SSC	Visitor
Arctic Peregrine Falcon	T	E	E	Transient
Southeastern Kestrel	- -	T	T	Resident
Bachman's Sparrow	C2	- -	- -	Visitor
Reddish Egret	C2	SSC	R	Visitor
West Indian Manatee	E	E	T	Resident in waters
Southeastern Beach Mouse	T	T	- -	Resident
Finback Whale	E			Offshore waters
Humpback Whale	E			Offshore waters
Right Whale	E			Offshore waters
Sperm Whale	E			Offshore waters
Sei Whale	E			Offshore waters
Florida Mouse	C2	SSC	T	Resident
Round-Tailed Muskrat	C2	- -	SSC	Possible resident

Source: Adapted from [USAF 1990], [NASA 1992]

NOTES:

- ^a Scientific names of listed species are in [NASA 1992] and [USAF 1990]
- ^b E = endangered; S/A = similarity of appearance; T = threatened; C2 = proposed for listing as threatened; R = rare; SSC = species of special consideration
FWS = U.S. Fish and Wildlife Service
FGFWFC = Florida Game and Fresh Water Fish Commission
FCREPA = Florida Commission on Rare and Endangered Plants and Animals
- ^c resident = a species that occurs on CCAS year-round
visitor = bird species that occurs at CCAS but does not nest there
transient = bird species that occurs on CCAS only during season of migration
not observed = species occurs either as a resident or as a visitor in Brevard County but has not been observed on CCAS

SECTION 4

ENVIRONMENTAL IMPACTS OF PROPOSED ACTION AND ALTERNATIVES

The activities associated with completing the preparations of the Mars Global Surveyor spacecraft primarily involve refining the spacecraft and mission designs at JPL, and spacecraft fabrication, assembly, and component testing at Lockheed Martin. While such fabrication activities may generate small quantities of effluents normally associated with tooling or cleaning operations, these are well within the scope of normal activities at the fabrication/testing facilities and will produce no substantial adverse environmental consequences.

Pre-launch activities (i.e., those activities occurring at the launch site) would involve integration and testing with the launch vehicle and final launch preparations, such as spacecraft and launch vehicle fueling operations, and would culminate in a successful nominal launch of the MGS spacecraft.

The following sections summarize the environmental effects of a normal Delta II 7925/PAM-D launch and flight, and the effects of possible abnormal spacecraft operations or flight conditions for the launch of the MGS spacecraft.

4.1 ENVIRONMENTAL IMPACTS OF A NORMAL DELTA II 7925 LAUNCH

4.1.1 AIR QUALITY

4.1.1.1 Emissions

Airborne emissions will be generated by prelaunch, launch, and post-launch operations. The majority of emissions will be produced by the graphite epoxy motor solid rockets (9 GEMs on the Delta II 7925 vehicle) and the liquid first stage of the Delta II vehicle during launch. Six of the GEMs and the first stage of the Delta II will be ignited during lift-off. The primary products of GEM combustion will be carbon monoxide (CO), carbon dioxide (CO₂), hydrochloric acid (HCl), aluminum oxide (Al₂O₃) in soluble and insoluble forms, nitrogen oxides (NO_x), and water. Combustion products of the GEM are listed in Table 4-1. Major exhaust products of the Delta II first stage will be CO, CO₂, and water. Exhaust products from the Delta II first stage are given in Table 4-2.

Other emissions resulting from Delta II operations include fuel and oxidant vapors which may escape to the atmosphere during prelaunch or post-launch operations. The first stage of the Delta II uses RP-1 as a fuel and liquid oxygen as an oxidizer. The vehicle's second stage employs Aerozine 50 as a fuel and nitrogen tetroxide (N₂O₄) as an oxidizer. Both stages will be loaded while the vehicle is on the launch pad.

Table 4-1. Combustion Products for the GEM Solid Rocket

Combustion Product	Product Mass Fraction	Product Mass per GEM		Product Mass for 6 Ground-Lit GEMs		Product Mass for 3 Air-Lit GEMs		Total Product Mass for 9 GEMs	
		kg	lb	kg	lb	kg	lb	kg	lb
AlCl	0.0002	2	5	14	31	7	16	21	47
AlCl ₂	0.0002	2	5	14	31	7	16	21	47
AlCl ₃	0.0001	1	3	7	16	4	8	11	24
AlClO	0.0001	1	3	7	16	4	8	11	24
Al ₂ O ₃ (soluble)	0.2959	3,512	7,727	21,074	46,363	10,537	23,181	31,611	69,544
Al ₂ O ₃ (insoluble)	0.0628	745	1,640	4,473	9,840	2,236	4,920	6,709	14,760
CO	0.2208	2,621	5,766	15,725	34,596	7,863	17,298	23,588	51,894
CO ₂	0.0235	279	614	1,674	3,682	837	1,841	2,511	5,523
Cl	0.0027	32	71	192	423	96	212	288	635
H	0.0002	2	5	14	31	7	16	21	47
HCl	0.2109	2,503	5,507	15,020	33,045	7,510	16,522	22,530	49,567
H ₂	0.0228	271	595	1,624	3,572	812	1,786	2,436	5,359
H ₂ O	0.0773	918	2,019	5,505	12,112	2,753	6,056	8,258	18,168
N ₂	0.0823	977	2,149	5,861	12,895	2,931	6,448	8,792	19,343
OH	0.0002	2	5	14	31	7	16	21	47

Source: Adapted from [MDSSC 1992]

Table 4-2. Exhaust Products for the Delta II 7925 First Stage

Combustion Product	Mass Fraction	Product Mass	
		kilograms	pounds
CO	0.4278	41,173	90,580
CO ₂	0.2972	28,603	62,928
H	0.0001	10	21
H ₂	0.0139	1,338	2,943
H ₂ O	0.2609	25,110	55,242
OH	0.0002	19	42

Source: Adapted from [MDSSC 1992]

Typically, RP-1 and liquid oxygen are be loaded into the first stage of the launch vehicle twice during the normal sequence of prelaunch operations. Minor amounts of fuel and oxidizer are loaded approximately two weeks prior to launch to test the fuel system's integrity. Following testing, the tanks are cleaned, and then loaded to full capacity within several hours before launch. Any fuel spillage that occurs during the loading process are collected in sealed trenches leading from the RP-1 storage tanks to the launch pad, and the RP-1 is then evacuated from these trenches into sealed 55 gallon drums for subsequent disposal by a certified subcontractor. Vapor losses during first stage loading are minimal, due to the low volatility of RP-1.

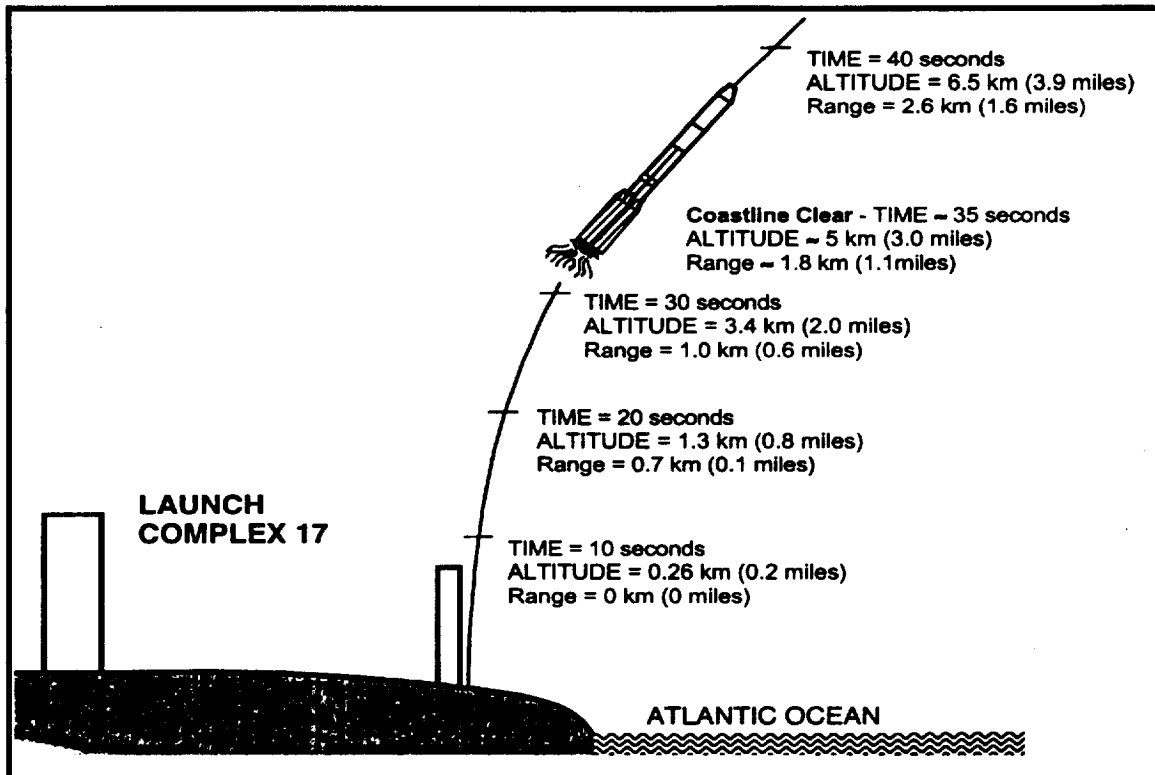
Aerozine 50 and N_2O_4 would be loaded into the second stage 3 days prior to the scheduled launch date. Pollution control devices are utilized to control emissions resulting from fuel and oxidizer handling operations. Chemical scrubbers are used to remove pollutants from the vapors; the scrubber solutions are then released into drums for disposal by a certified subcontractor. Spillage of Aerozine 50 or N_2O_4 , although not expected, would be in accordance with OPlan 19-1.

Emergency release could occur during the rupture of a part of the propellant loading system, mainly as a result of over pressurization of the system. Redundant flow meters and automatic shutdown devices on the propellant loading system would prevent overfilling of the propellant tanks. Automatic pressure monitoring devices on the tanks and feed system are designed to prevent over pressurization.

In the unlikely event of a vehicle destruction on the pad, failure in flight, or a command destruct action, liquid propellant tanks and GEM casings are ruptured. Under these circumstances, most of the released liquid propellants would ignite and burn. Rupture of the GEM casings creates a sudden reduction in chamber pressure, which acts to extinguish most of the solid propellants, so that only a portion may continue to burn.

4.1.1.2 Impacts

In a normal launch, exhaust products from the Delta II 7925 (Tables 4-1 and 4-2) are distributed along the launch vehicle's path (Figures 4-1, 4-2a, and 4-2b). The quantities of exhaust emitted per unit length of the trajectory are greatest at ground level and decrease continuously. The portion of the exhaust plume that persists longer than a few minutes (the ground cloud) is emitted during the first few seconds of flight and is concentrated near the pad area. Prior to launch all non-essential personnel are evacuated from the launch site to areas a minimal distance outside the facility perimeter. Necessary personnel remain inside the complex blockhouse until the area has been monitored and declared clear. Little information has been developed specifically for the Delta vehicle, but data from the Titan program has been used as a basis for comparison. [USAF 1988]

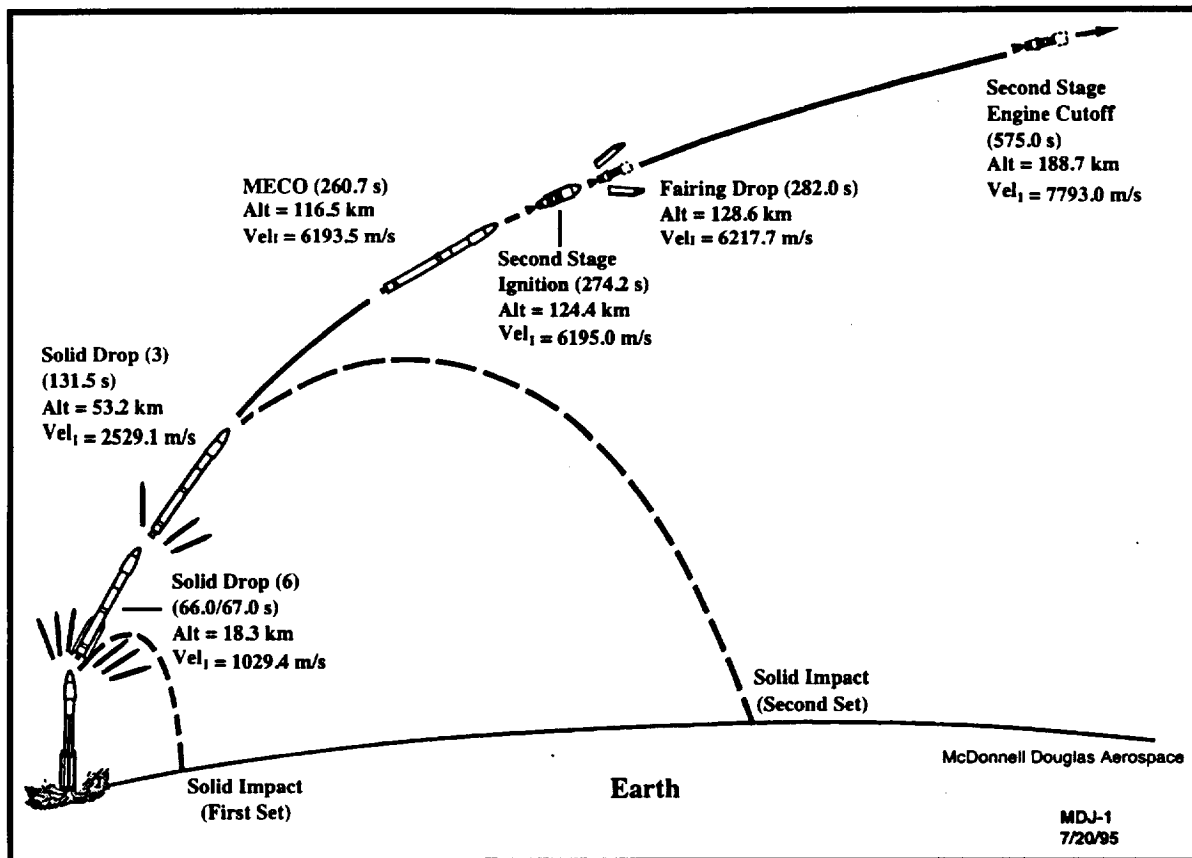


Source: Adapted from [MDA 1993]

Figure 4-1. Delta II 7925 Launch Area Flight Profile

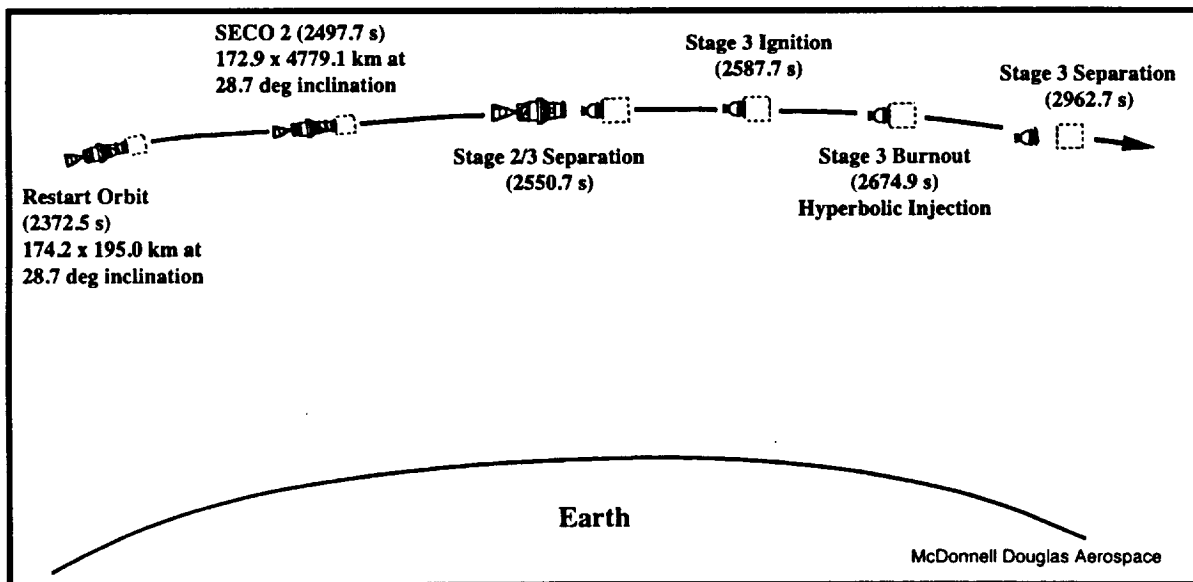
To estimate the peak ground level concentrations of ground cloud pollutants, the U.S. Air Force has extrapolated Delta II exhaust plume diffusion data from the models developed for the Titan launch vehicle program. These Titan models are used to calculate peak ground level concentrations of various pollutants in ground clouds. Due to the similarity in propellant types, the Delta vehicle ground cloud will be similar in composition to that produced by the Titan. However, the size of the Delta ground cloud should be considerably smaller than that of the Titan because the Delta vehicle and solid rocket GEMs contain 80 percent less propellant, produce less vapor, and accelerate off the launch pad more quickly than the Titan. The ground cloud resulting from a normal Delta II launch is predicted to have a radius of about 20 m (67 ft).

From these estimates, HCl concentrations from a Delta II ground cloud should not exceed 5 ppm beyond about 4.3 km (2.7 mi) downwind. The Occupational Health and Safety Administration (OSHA) permissible exposure limit (PEL) for HCl is 5 ppm for an 8-hour time-weighted average. Although National Ambient Air Quality Standards have not been adopted for HCl, NAS developed recommended short-term exposure limits for HCl of 20 ppm for a 60-minute exposure, 50 ppm for a 30-minute exposure, and 100 ppm for a 10-minute exposure.



Source: Adapted from [JPL 1994-B]

Figure 4-2a. Delta II Boost Profile for MGS



Source: Adapted from [JPL 1994-B]

Figure 4-2b. Delta II Injection Profile for MGS

Since the nearest uncontrolled area (i.e., general public) is approximately 4.8 km (3 mi) from LC-17, HCl concentrations are not expected to be high enough to be harmful to the general population. The maximum level of HCl expected to reach uncontrolled areas during preparation and launch of the Delta II would be well below the NAS recommended limits. Appropriate safety measures would also be taken to ensure that the permissible exposure limits defined by the OSHA are not exceeded for personnel in the launch area.

The same predictive modeling techniques used for HCl were also applied to CO and Al_2O_3 . For Titan launches, CO concentrations were predicted to be less than 9 ppm except for brief periods during actual lift-off. Prior to, during, and for about 20 minutes after launch, the area within the perimeter is cleared of personnel in accordance with Range Safety practices. During launch, gases are exhausted at temperatures ranging from 2,000 to 3,000 degrees F. Most of the gases then immediately rise to an altitude of about 2,000 feet, where they are dispersed by the prevailing winds. Moreover, carbon monoxide gas is expected to rapidly oxidize to carbon dioxide (CO_2) in the atmosphere, and therefore, CO concentrations for Titan launches are not expected to exceed the NAAQS of 35 ppm (1-hour average) beyond the immediate vicinity of the launch complex. The nine GEMs used for the Delta launch constitute less than 20 percent of the propellant loading of the two SRMUs, and therefore, the CO concentration for a Delta launch is predicted to be on the order of 2 ppm (1-hour average).

Aluminum oxide exists as a crystalline dust in solid rocket motor (SRM) exhaust clouds, but is inert chemically and is not toxic. However, since many of the dust particles are small enough to be retained by lungs, it is appropriate to abide by NAAQS for particulate matter smaller than 10 microns (PM-10). The maximum 24-hour Al_2O_3 concentration beyond the distance of the nearest CCAS property boundary predicted by the Rocket Effluent Exhaust Dispersion Model (REEDM) for a Titan IV-Type 2 launch, was $25 \mu\text{g}/\text{m}^3$, which is well below the 24-hour average PM-10 NAAQS for PM-10 of $150 \mu\text{g}/\text{m}^3$. [USAF 1990] Scaling from the Titan IV REEDM predictions, based on the solid propellant mass proportion of the Delta II 7925, the Al_2O_3 peak concentrations should not exceed $5 \mu\text{g}/\text{m}^3$. The NAAQS for continuous emitters of particulate matter should not be exceeded by a Delta II launch due to the short nature of the launch event.

Nitrogen oxides (NO_x) may enter the atmosphere through propellant system venting, a procedure used to maintain proper operating pressures. Air emission control devices will be used to mitigate this small and infrequent pollutant source. First stage propellants will be carefully loaded using a system with redundant spill-prevention safeguards. Aerozine 50 vapors from second stage fuel loading will be processed to a level below analytical detection by a citric acid scrubber. Likewise, N_2O_4 vapors from second stage oxidizer loading will be passed through a sodium hydroxide (NaOH) scrubber. These scrubber wastes will be disposed by a certified hazardous waste contractor according to the CCAS Petroleum Products and Hazardous Waste Management Plan. [OPlan 19-14] The scrubber operation is a FDEP permitted activity. Air emissions monitoring is conducted in accordance with the FDEP permit.

During the last 20 years there has been an increased concern about human activities that are affecting the upper atmosphere. Space vehicles that use SRMs have been studied concerning potential contribution to stratospheric ozone depletion because of their exhaust products, with the primary depleting component being HCl. Extrapolating from estimates made

using the REEDM model for the Titan IV-Type 2 solid rocket motor upgrades (SRMUs) effects on stratospheric ozone, the net decrease in ozone resulting from launching eight Titan IV-Type 2 (SRMUs) over a twelve-month period is predicted to be on the order of 0.02 percent. [USAF 1990] A Delta II 7925 with nine GEMS is less than 20% of the SRMUs propellant loading. Therefore, scaling from the Titan IV-Type 2 prediction, the net stratospheric ozone depletion from nine GEMS, which are planned for use with the Delta II, has been predicted to be on the order of 0.0005 percent. Based on the history of six Delta launches per year average for the past eight years, launching six Delta II 7925's with nine GEMS in a twelve-month period is extrapolated to result in a cumulative net stratospheric ozone depletion on the order of 0.003 percent.

In addition to the near-pad acidic deposition that could occur during a launch, there is a possibility of acid precipitation from naturally-occurring rain showers falling through the ground cloud shortly after launch. Since the ground cloud for a Delta II launch is very small (radius of about 20 m or 67 ft) and concentrates around the launch pad, there should be no significant acid rain beyond the near-pad area.

4.1.2 LAND RESOURCES

Overall, launching a Delta II vehicle is expected to have negligible negative effects on the land forms surrounding LC-17. [USAF 1988] However, launch activities could have some small impacts near the launch pad associated with fire and acidic depositions. Minor brush fires are infrequent by-products of Delta launches, and are contained and limited to the ruderal vegetation within the launch complexes; past singeing has not permanently affected the vegetation near the pads. Wet deposition of HCl, caused by rain falling through the ground cloud or SRM exhaust, could damage or kill vegetation. Wet deposition is not expected to occur outside the pad fence perimeter, due to the small size of the ground cloud and the rapid dissipation of both the ground cloud and SRM exhaust plume. [USAF 1990]

4.1.3 LOCAL HYDROLOGY AND WATER QUALITY

Water, supplied by municipal sources, is used at LC-17 for deluge water (for fire suppression), launch pad washdown, and potable water. Most of the deluge and launch pad washdown water is collected in a concrete catchment basin; however, minor amounts may drain directly to grade. The only potential contaminants used on the launch pad are fuel and oxidizer, and the only release of these substances would occur within sealed trenches and should not contaminate runoff. Any accidental or emergency release of propellants from the Delta vehicle after fueling would be collected in the flume located directly beneath the launch vehicle and channeled to a sealed concrete catchment basin. If the catchment basin water meets the criteria set forth in the FDEP industrial wastewater discharge permit, it is discharged directly to grade at the launch site. If it fails to meet the criteria, it is treated on site and disposed to grade or collected and disposed of by a certified contractor. No discharges of contaminated water are expected to result from medium launch vehicle operations at LC-17. To ensure this, the groundwater in the discharge area is monitored quarterly by Air Force Bioenvironmental Engineering Services.

The primary surface water impacts from a normal Delta II launch involve HCl and Al_2O_3 deposition from the ground cloud. The cloud will not persist or remain over any location for more than a few minutes. Depending on wind direction, most of the exhaust may drift over the Banana River or the Atlantic Ocean, resulting in a brief acidification of surface waters from HCl. Aluminum oxide is relatively insoluble at the pH of local surface waters and is not expected to cause elevated aluminum levels or significant acidification of surface waters. The relatively large volume of the two bodies of water compared to the amount of exhaust released is a major factor working to prevent a deep pH drop and fish kills associated with such a drop. There have been no fish kills recorded in the Atlantic Ocean or Banana River as a result of HCl and Al_2O_3 deposition during a normal launch. [45 AMDS/SGPB] A normal Delta II launch will have no substantial impacts to the local water quality.

4.1.4 OCEAN ENVIRONMENT

In a normal launch, the first stage and GEMS will impact the ocean. The trajectories of spent first stage and GEMs would be programmed to impact a safe distance from any U.S. coastal area or other land mass. Toxic concentrations of metals are not likely to occur due to the slow rate of corrosion in the deep ocean environment and the large quantity of water available for dilution.

Since the first stage and GEMS will be burned to depletion in-flight, there would be relatively small amounts of propellant. The release of solid propellants into the water column would be slow, with potentially toxic concentrations occurring only in the immediate vicinity of the propellant. Insoluble fractions of the first stage propellant would spread rapidly to form a localized surface film that will evaporate in several hours. Second stage propellants are soluble and should also disperse rapidly.

Concentrations in excess of the maximum allowable concentration (MAC) of these compounds for marine organisms would be limited to the immediate vicinity of the spent stage. No substantial impacts are expected from the reentry and ocean impact of spent stages, due to the small amount of residual propellants and the large volume of water available for dilution. [USAF 1988]

4.1.5 BIOTIC RESOURCES

A normal Delta II launch is not expected to substantially impact CCAS terrestrial, wetland, or aquatic biota. The elevated noise levels of launch are of short duration and would not substantially affect wildlife populations. Wildlife encountering the launch-generated ground cloud may experience brief exposure to exhaust particles, but would not experience any significant impacts. Aquatic biota may experience acidified precipitation, if the launch occurs immediately after a rain shower. This impact is expected to be insignificant due to the brevity of the ground cloud and the high buffering ability of the surrounding surface waters to rapidly neutralize excess acidity.

4.1.6 THREATENED AND ENDANGERED SPECIES

Any action that may affect federally listed species or their critical habitats requires consultation with the U.S. Fish and Wildlife Service (FWS) under Section 7 of the Endangered Species Act of 1973 (as amended). The U.S. FWS has reviewed the actions which would be associated with a Delta II launch from LC-17 and has determined that those actions would have no effect on state or federally listed threatened (or proposed for listing as threatened) or endangered species residing on CCAS and adjoining waters. [USAF 1988] [NASA 1992]

4.1.7 DEVELOPED ENVIRONMENT

4.1.7.1 Population and Socioeconomics

Launching the Mars Global Surveyor mission will have a negligible impact on local communities, since no additional permanent personnel are expected beyond the current CCAS staff. LC-17 has been used exclusively for space launches since the late 1950s. The MGS mission would cause no additional adverse impacts on community facilities, services, or existing land uses.

4.1.7.2 Safety and Noise Pollution

The "Medium Launch Vehicle Accident Risk Assessment Report" [MDSSC 1986] describes the launch safety aspects of the Delta II vehicle, support equipment, and LC-17 facilities. The report identifies design and operating limits that would be imposed on system elements to preclude or minimize accidents resulting in damage or injury. Normal operations at CCAS include preventative health measures for workers such as hearing protection, respiratory protection, and exclusion zones to minimize or prevent exposure to harmful noise levels or hazardous areas or materials.

The engine noise and sonic booms from a Delta II launch are typical of routine CCAS operations. To the surrounding community, noise from launch-related activity appears, at worst, to be an infrequent nuisance rather than a health hazard. In the history of the USAF space-launch vehicle operations from CCAS, there have been no problems reported as a result of sonic booms, most probably because the ascent track of all vehicles and the planned reentry of spent suborbital stages are over open ocean, thus placing sonic booms away from land areas. Shipping in the area likely to be affected is warned of the impending launches as a matter of routine, so that all sonic booms are expected and of no practical consequence. [USAF 1988]

4.1.7.3 Cultural Resources

Since no surface or subsurface areas would be disturbed, no significant archaeological, historic, or other cultural sites are expected to be affected by launching the MGS spacecraft.

4.2 ACCIDENTS AND LAUNCH FAILURES

4.2.1 LIQUID PROPELLANT SPILL

The potential for an accidental release of liquid propellants will be minimized by strict adherence to established safety procedures. First stage propellants, RP-1 and liquid oxygen, will be stored in tanks near the launch pad within cement containment basins designed to retain 110 percent of the storage tank volumes. Post-fueling spills from the launch vehicle would be channeled into a sealed concrete catchment basin and disposed of in accordance with OPlan 19 -1. Second stage propellants, Aerozine 50 and N_2O_4 , are not stored at LC-17 and would be transported to the launch site by specialized vehicles.

The most severe propellant spill accident scenario would be releasing the entire launch vehicle load of N_2O_4 at the launch pad while conducting propellant transfer operations. This scenario would have the greatest potential impact on local air quality. Using again the Titan REEDM predictive models and scaling for the Delta propellant loading, airborne NO_x levels from this scenario should be reduced to 5 ppm within about 150 m (500 ft) and to 1 ppm within 300 m (984 ft). Activating the launch pad water deluge system would substantially reduce the evaporation rate, limiting exposure concentrations in the vicinity of the spill that are above federally established standards. Propellant transfer personnel would be outfitted with protective clothing and breathing equipment. Personnel not involved in transfer operations would be excluded from the area during such operations.

4.2.2 LAUNCH FAILURES

In the unlikely event of a launch vehicle destruction, either on the pad or in-flight, the liquid propellant tanks and SRM cases would be ruptured. Due to their hypergolic (ignite on contact) nature, a launch failure would result in a spontaneous burning of most of the liquid propellants, and a somewhat slower burning of SRM propellant fragments. Tables 4-3 and 4-4 define the combustion products of a GEM SRM failure and a catastrophic launch pad failure. This release of pollutants would have only a short-term impact on the environment near LC-17.

Launch failure impacts on water quality would stem from unburned liquid propellant being released into CCAS surface waters. For most launch failures, propellant release into surface waters will be substantially less than the full fuel load, primarily due to the reliability of the vehicle destruct system.

If there was an early flight termination and failure of the vehicle destruct system, it is remotely possible that the entire stage 2 propellant quantity could be released to the ocean. Shallow or confined surface water systems, such as aquifers, ponds, etc., would receive most of the impact. The release of the entire RP-1 fuel load in this near-pad intact vehicle impact scenario would form a very thin film (less than 0.003 cm, or 0.001 in) covering a water surface area less than 4.4 sq km (1.7 sq mi). This film would be expected to dissipate within a few hours. In this hypothesized worst case, which has never occurred for the Delta II, Aerozine 50 and N_2O_4 contaminants could exceed allowable concentrations for an approximate radius of 241 m (800 ft) in water depths exceeding 3 m (9 ft) deep. However, even given this worst case scenario, the

impacts to ocean systems would be localized and/or transient in nature, and expected to recover rapidly due to dilution in such a large amount of ocean water for dilution and buffering.
[USAF 1988]

Table 4-3. Combustion Products for Delta II 7925 GEM Failure Scenario

Combustion Product	Product Mass Fraction	Total Propellant Mass of 105,872 kg	
		kg	lb
Al ₂ O ₃	0.1759	18,623	40,971
Ar	0.0064	678	1,492
C	0.0143	1,514	3,331
CH ₄	0.0000	0	0
CO ₂	0.1329	14,070	30,954
Cl ₂	0.0000	0	0
HCl	0.1071	11,339	24,946
H ₂ O (liquid)	0.1274	13,488	29,674
H ₂ O (gaseous)	0.0136	1,440	3,168
N ₂	0.4188	44,339	97,546
O ₂	0.0000	0	0

Source: Adapted from [MDSSC 1992]

Table 4-4. Combustion Products for Delta II 7925 Catastrophic Failure Scenario

Combustion Product	Product Mass Fraction	Total Propellant Mass of 209,433 kg	
		kg	lb
Al ₂ O ₃	0.0926	19,393	42,666
Ar	0.0064	1,340	2,949
C	0.0191	4,000	8,800
CO ₂	0.2514	52,651	115,833
Cl ₂	0.0000	0	0
HCl	0.0551	11,540	25,387
H ₂ O (liquid)	0.1556	32,588	71,693
H ₂ O (gaseous)	0.0141	2,953	6,497
N ₂	0.4051	84,841	186,651
O ₂	0.0000	0	0

Source: Adapted from [MDSSC 1992]

4.3 ENVIRONMENTAL IMPACTS OF ALTERNATIVES

Of the alternate launch vehicle systems available, only the Atlas I/Centaur is capable of meeting, but not greatly exceeding, the MGS mission requirements. While the Atlas I/Centaur uses slightly less fuel, the reliability record of the Delta exceeds that of the Atlas, and the Atlas costs significantly more. The environmental impact of using a Delta II launch vehicle would be approximately the same as using the Atlas I/Centaur.

Other launch vehicle alternatives would contribute potentially greater environmental impacts, at a significantly higher cost to launch.

SECTION 5

REGULATORY REVIEW

5.1 AIR QUALITY

The Florida Department of Environmental Protection (FDEP) regulates air pollutant emission sources in Florida and requires permits for the construction, modification, or operation of potential air pollution sources [FDEP 1986]. Emissions from mobile sources, such as aircraft and space launch vehicles, do not require a permit. This exception does not include support facilities, such as propellant loading systems.

Stationary, ground-based sources associated with space vehicle launches are subject to FDEP review. Because no new stationary sources would be constructed for the MGS launch, there is no requirement for new air quality permits.

The Delta II oxidizer and fuel vapor air pollution control devices at CCAS are in compliance with NAAQS standards and FDEP regulations. The citric acid scrubber for Delta II propellants is probably one level of control beyond that required by the FDEP.

5.2 WATER QUALITY

5.2.1 STORMWATER DISCHARGE

Florida's stormwater discharge permitting program is designed to prevent adverse effects on surface water quality from runoff. A discharge permit will not be required for MGS because the launch would not increase stormwater runoff rates or reduce the quality of the existing runoff.

5.2.2 SANITARY AND INDUSTRIAL WASTEWATER DISCHARGE

LC-17 and the MGS spacecraft and launch vehicle assembly facilities have potable water and sanitary waste disposal permits. No new permits will be required for the MGS assembly or launch.

Wastewater from LC-17 would include deluge and pad washdown water discharged during MGS launch activities. An application has been filed with the FDEP to permit discharge from LC-17. The permit will be issued based on demonstration that discharge would not significantly degrade surface or ground water.

5.2.3 FLOODPLAINS AND WETLANDS

LC-17 is not located on a floodplain. Impacts to wetlands from the launch of the MGS would not exacerbate impacts from other CCAS activities or launches. Therefore, no new permits would be required for the MGS launch.

5.3 HAZARDOUS WASTES

CCAS was issued a Resource Conservation and Recovery Act (RCRA), Part B Hazardous Waste Operations permit in January 1986 [USAF 1986]. All hazardous wastes generated at CCAS will be managed according to the CCAS Petroleum Products and Hazardous Waste Management Plan (OPlan 19-14). Hazardous wastes produced during processing and launch operations will be collected and stored in hazardous waste accumulation areas before being transferred to a hazardous storage area. These wastes will eventually be transported to an off-station licensed hazardous waste treatment/disposal facility.

5.4 SPILL PREVENTION

To prevent oil or petroleum discharges into U.S. waters, a Spills Prevention, Control, and Countermeasures Plan (SPCCP) is required by the Environmental Protection Agency's oil pollution prevention regulation. A SPCCP has been integrated into the CCAS Oil and Hazardous Substance Pollution Contingency Plan (OPlan 19-1). Spills of oil or petroleum products that are federally listed hazardous materials will be collected and removed for proper disposal by a certified contractor according to CCAS OPlan 19-4, Hazardous Substance Pollution Contingency Plan [USAF 1990]. All spills/releases will be reported to the host installation per OPlan 19-1.

5.5 COASTAL MANAGEMENT PROGRAM

The Federal Coastal Zone Management Act of 1972 established a national policy to preserve, protect, develop, restore, and/or enhance the resources of the nation's coastal zone. The Act requires federal agencies that conduct or support activities directly affecting the coastal zone, to perform these activities in a manner that is, to the maximum extent practicable, consistent with approved state coastal zone management programs.

Delta II launches from LC-17 have been demonstrated to be consistent to the maximum extent practical with the State of Florida's Coastal Management Program, based on compatible land use, absence of significant environmental impacts and compliance with applicable regulations. [USAF 1986] MGS mission processing and launch would add no substantial impact beyond those determined to be associated with the Delta II.

5.6 CULTURAL RESOURCES

In accordance with 36 CFR Part 800, the Florida Department of State, Division of Historical Resources, has reviewed the planned Mars Pathfinder launch for possible impact to archaeological and historical sites or properties listed, or eligible for listing, in the National Register of Historic Places. Their review indicates that no significant archaeological or other historical sites are recorded in the Florida Master Site File, nor are any likely to appear there. They consider it unlikely that any such sites would be affected by the proposed action. [FLORIDA 1993] Based on the fact that MGS is planned to be launched on the same type of launch vehicle from the same launch pad, and requires no new facilities, it is assumed that the MGS mission would also be unlikely to affect any significant cultural sites.

NASA has also determined that the proposed action will have no effect on property listed in the National Register of Historic Places.

5.7 CORRESPONDENCE WITH FEDERAL AGENCIES

5.7.1 UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (no response received)

5.8 CORRESPONDENCE WITH STATE AGENCIES

5.8.1 FLORIDA STATE CLEARINGHOUSE (response included in Appendix A)

SECTION 6

REFERENCES

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- FDEP 1986 Florida Department of Environmental Protection, Florida Administrative Code, *Air Pollution Sources*, Chapter 17-2, October 1986.
- FLORIDA 1993 Florida Department of State Division of Historical Resources response to Florida State Clearinghouse, July 1993.
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- JPL 1995-B Memorandum 311-5/95-005 to Mary Kaye Olsen, NASA HQ, Code SLN, from J. Mark Phillips of LAPG at JPL, re: USAF 45 CES/CEV Concurrence in Pathfinder Assessment Closure Actions, March 15, 1995.
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JPL 1995-E	Private communication from Henry Moore of EG & G Environmental Health Services, contractor at KSC, to J. Mark Phillips and Janis Graham, August 11, 1995.
JPL 1995-F	Private communication from Peter Theisinger, MGS Project Engineer, Jet Propulsion Laboratory, Mars Global Surveyor Project, July 16, 1995.
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USAF 1991

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APPENDIX A
CORRESPONDENCE WITH STATE AND FEDERAL AGENCIES

NOTE:

While preparing this Environmental Assessment, NASA solicited comments from a range of Federal and Florida State Agencies.

A distribution list may be found at the end of the NASA
Letter of Intent dated January 23, 1995.

There has been formal correspondence with
Patrick Air Force Base and Kennedy Space Center.
NASA has been assured by appropriate liaisons at these installations
that their comments have been addressed to their satisfaction.

This appendix contains the comments received from
Federal and Florida State Agencies.
Where no other agency written response is provided in this
appendix, none was received.



Reply to Attn of: SL

JAN 23 1995

To Potentially Concerned Agencies:

NASA is seeking approval for plans to launch the Mars Global Surveyor (MGS) spacecraft on a mission to orbit Mars and gather information about its surface and climate. Current mission plans call for the spacecraft to be launched in November 1996 from the Eastern Test Range at the Cape Canaveral Air Station, Cape Canaveral, Florida. In accordance with policies of NASA and requirements of the National Environmental Protection Act, NASA is preparing an Environmental Assessment to evaluate any mission-specific environmental impacts.

The MGS mission would be designed to fulfill the most critical objectives of the failed Mars Observer mission and is planned as part of NASA's solar system exploration program. As conceived, data gathered by the MGS orbiter would enable a future series of missions to Mars in a decade-long exploration of the planet with multiple spacecraft including orbiters, landers, and rovers. Each of these future missions would be planned to take advantage of launch opportunities that occur approximately every 2 years as Mars comes into alignment with Earth.

The baseline plan calls for MGS to be designed as a solar-powered spacecraft small enough to be launched on a Delta II 7925 launch vehicle. A solid propellant Payload Assist Module Delta (PAM-D) upper stage will then place the spacecraft onto a flight path to Mars. The MGS spacecraft will carry no radioactive materials.

Prelaunch spacecraft testing and propellant loading operations would occur at the Kennedy Space Center and the Cape Canaveral Air Station (CCAS), in Florida. After processing, the spacecraft would be transferred to the CCAS Launch Complex 17 for mating with the launch vehicle. No requirements for new or modified Government or contractor facilities have been identified, and no new facilities or modifications are planned for the mission.

The MGS Environmental Assessment will address the Proposed Action of preparing for and implementing the MGS mission to be launched from the Cape Canaveral Air Station (CCAS) using the Delta II 7925/PAM-D launch system. Options discussed will include, but not necessarily be limited to, the use of alternative launch vehicles and the no action alternative.

The primary environmental impacts expected are those associated with the launch vehicle, which are discussed in *U.S. Department of the Air Force, Headquarters Space Division, Environmental Assessment: Air Force Space Division, Medium Launch Vehicle Program, Cape Canaveral Air Force Base, Florida* (Environmental Science and Engineering Inc., Gainesville, Florida, May 1988). Those effects include the impact of rocket fuel combustion products on the quality of air, water, land and wetland, biotic resources, and historical sites. Other topics to be addressed in the Environmental Assessment are safety concerns and socioeconomic impacts. The result of the Environmental Assessment is expected to be released for public review and comment in August 1995.

Any comments you may presently have should be sent to me within 30 days of the date of this letter, at NASA Headquarters, Code SL, 300 E Street, SW, Washington, DC, 20546. If you need further information, please contact Mr. Kenneth M. Kumor at NASA Headquarters at (202) 358-1112.

Sincerely,

William L. Piotrowski

William L. Piotrowski
Acting Director
Solar System Exploration Division
Office of Space Science

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Mr. E. Gormel
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U.S. Fish and Wildlife Service/Mr. A. Hight



**STATE OF FLORIDA
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LAWTON CHILES
Governor

LINDA LOOMIS SHELLEY
Secretary

August 4, 1995

Ms. Mary Kaye Olsen
National Aeronautics and Space
Administration Headquarters
Code SLP
Washington, D. C. 20546

RE: National Aeronautics and Space Administration Projects
- Concurrence Draft Environmental Assessment for the
Mars Global Surveyor - Cape Canaveral Air Station,
Brevard County, Florida
SAI: FL9506070600C (Also FL9501270047CR1)

Dear Ms. Olsen:

The Florida State Clearinghouse, pursuant to Presidential Executive Order 12372, Governor's Executive Order 93-194, the Coastal Zone Management Act, 16 U.S.C. §§ 1451-1464, as amended, and the National Environmental Policy Act, 42 U.S.C. §§ 4321, 4331-4335, 4341-4347, as amended, has coordinated a review of the above-referenced project.

The Department of Environmental Protection (DEP) indicates that the applicant may have inadvertently overlooked issues raised on page two of the DEP's March 29, 1995, comments provided following its review of the Headquarters Review Draft. Please refer to the DEP's enclosed March 29, 1995 and July 25, 1995 letters for further discussion of those issues which should be addressed in the Final Environmental Assessment.

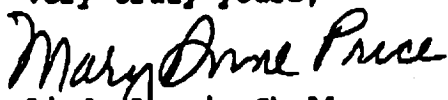
Based on the information contained in the above-referenced document and the enclosed comments provided by our reviewing agencies, the state has determined that, at this stage, the above-referenced project is consistent with the Florida Coastal Management Program (FCMP). All subsequent environmental

EMERGENCY MANAGEMENT • HOUSING AND COMMUNITY DEVELOPMENT • RESOURCE PLANNING AND MANAGEMENT

Ms. Mary Kaye Olsen
August 4, 1995
Page Two

documents prepared for this project must be reviewed to determine the project's continued consistency with the RCMP. The state's continued concurrence with the project will be based, in part, on the adequate resolution of issues identified during earlier reviews.

Very truly yours,


for Linda Loomis Shelley
Secretary

LLS/rk

Enclosures

cc: Susan Goggin, Department of Environmental Protection
George Percy, Department of State
Wynnelle Wilson, Department of Commerce



STATE OF FLORIDA
DEPARTMENT OF COMMUNITY AFFAIRS

2740 CENTERVIEW DRIVE • TALLAHASSEE, FLORIDA 32399-2100

LAWTON CHILES
Governor

LINDA LOOMIS SHELLEY
Secretary

April 25, 1995

Ms. Mary Kay Olsen
National Aeronautics and
Space Administration Headquarters
Washington, DC 20546

RE: National Aeronautics and Space Administration Projects
- Mars Global Surveyor Mission - Headquarters Review
Draft Environmental Assessment - Cape Canaveral Air
Station, Brevard County, Florida
SAI: FL9501270047CR

Dear Ms. Olsen:

The Florida State Clearinghouse, pursuant to Presidential Executive Order 12372, Gubernatorial Executive Order 93-194, the Coastal Zone Management Act, 16 U.S.C. §§ 1451-1464, as amended, and the National Environmental Policy Act, 42 U.S.C. §§ 4321, 4331-4335, 4341-4347, as amended, has coordinated a review of the above-referenced project.

The Department of Environmental Protection (DEP) recommends that the draft Environmental Assessment be revised to incorporate the changes identified in the enclosed DEP comments.

The state has reviewed the above-referenced draft Environmental Assessment (EA) and based on the information contained in the EA and the enclosed comments provided by our reviewing agencies, the state has determined that, at this stage, the proposed action is consistent with the Florida Coastal Management Program. Notwithstanding the state's consistency

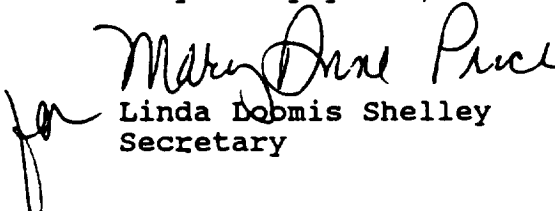
Ms. Mary Kay Olsen

April 25, 1995

Page Two

determination, the applicant is required to modify the final EA to incorporate the changes identified by the DEP, as enclosed.

Very truly yours,


for Linda Dobmis Shelley
Secretary

LLS/jr

Enclosures

cc: Susan Goggin, Department of Environmental Protection
Margaret Spontak, St. Johns River Water Management District



Department of Environmental Protection

Lawton Chiles
Governor

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

Virginia B. Wetherell
Secretary

29 March 1995

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APR 5 1995

Florida Coastal
Management

Suzanne Traub-Metlay
State Clearinghouse
Office of Planning & Budgeting
Executive Office of the Governor
The Capitol
Tallahassee, Florida 32399-0001

RE: NASA/Mars Global Surveyor Mission Environmental
Assessment, Brevard County
SAI: FL9501270047CR

Dear Ms. Traub-Metlay:

We have reviewed the Environmental Assessment (EA) which examines the potential impacts related to implementation of the Mars Global Surveyor (MGS) Mission. The proposed action involves the integration of the MGS spacecraft and its launch from Cape Canaveral Air Station (CCAS) from Launch Complex 17. Based on the information provided, we find the proposed action to be consistent with our authorities in the Florida Coastal Management Program, and request that the following be addressed in the final EA:

Pg. 3-11, First paragraph: The narrative should read "Orange County was a non-attainment area for ozone until 1987.... redesignated as an ozone attainment maintenance area". Please add the word "maintenance" to differentiate between attainment area and attainment maintenance area.

Pg. 3-11, Third paragraph: It is stated that CCAS has experienced six exceedances of the ambient air quality for ozone. The document should provide information as to when, where, how much, and to whom the exceedances were reported. Possible violations of federal and state ambient air rules may mean that Brevard County is a non-attainment area for ozone if more than three exceedances occurred over a three-year period. In addition, were these measurements accepted by EPA methods?

Pg. 3-12, Table 3.1:

1. The Federal primary annual arithmetic mean for sulfur dioxide is 80ug/m3 and 0.03 ppm.

Mars Global Surveyor Mission
FL9501270047CR
Page Two

2. The table should be changed from Total Suspended Particulates to Particulate Matter 10 (PM10). The Department removed all standards for the High Volume Standards.

3. The table reads 35 ppm standard for both Annual Arithmetic Means. This is an error. There is no reference in the state or federal limits for 35 ppm.

4. Regarding the reference in the note section for "+". This should be expanded to read over a three-year period.

Pg. 4-2: Data should be supplied in the context of ambient concentration as well.

Pg. 4-6:

1. Predictive model levels of CO were not given. The actual Titan launches for CO was not given, so the statement "a Delta launch should be considerably lower" has no relevant meaning.


2. PM10 aluminum oxide should not exceed 11 mg/m3. This exceeds the 150 24 ug/m3 federal and state standards.

3. Is aluminum oxide chemically inert? The micron size for aluminum oxide is .1 and as the PM10 only measures above .3 of micron, a special Teflon filter must be utilized to measure it.

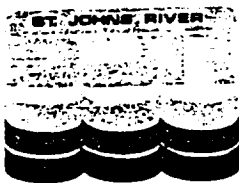
Pgs. 4-6, 4-7: Statements on ozone depletion are unclear and lack supporting data.

We appreciate the opportunity to provide comments on the Draft EA for the Mars Global Surveyor Mission. Questions regarding the above comments may be direct to Chuck Collins, DEP Central District, at (407)894-7555. If I may be of further assistance, please feel free to call me at 487-2231.

Sincerely,


Susan Goggin
Environmental Specialist, MS 47
Office of Intergovernmental Programs

CC/s
cc: Chuck Collins



**WATER
MANAGEMENT
DISTRICT**

Henry Dean, Executive Director
John R. Wehle, Assistant Executive Director
Charles T. Myers III, Deputy Assistant Executive Director

POST OFFICE BOX 1429 PALATKA, FLORIDA 32178-1429
TELEPHONE 904/329-4500 SUNCOM 904/860-4500
TDD 904/329-4450 TDD SUNCOM 860-4450
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PERMITTING: 305 East Drive Melbourne, Florida 32904 407/984-4940 TDD 407/772-5368	OPERATIONS: 2133 N. Wickham Road Melbourne, Florida 32935-8109 407/254-1762 TDD 407/253-1203

April 3, 1995

Ms. Suzanne Traub-Metlay
Florida State Clearinghouse
Executive Office of the Governor - OPB
Room 1603, The Capitol
Tallahassee, FL 32399-0001

Re: FL9501270047CR
NASA - Mars Global Surveyor Mission Environmental Assessment

Dear Ms. Traub-Metlay:

The Staff of St. Johns River Water Management District has reviewed this plan and found it consistent with the Coastal Zone Management Act. The District strongly supports reuse projects such as this one. The design and plan for the project is excellent.

This letter does not constitute or substitute for a permit review. Permit reviews require more specific information.

Sincerely,

Margaret Spontak, Director
Division of Policy and Planning

MS/ch

c: Florida Coastal Management

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APR 6 1995

Florida Coastal
Management Program

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			James T. Swann COCOA

COUNTY: BREVARD

DATE: 04/17/95
COMMENT DUE DATE: 03/29/95
CLEARANCE DUE DATE: 04/19/95
SAI#: FL9501270047CR

STATE AGENCIES

Community Affairs
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Game and Fresh Water Fish Comm
Transportation

LOCAL/OTHER

St. Johns River Water Manag. District

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Environmental Policy/C & ED

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Florida Coastal
Management Program

The attached document requires a Coastal Zone Management Act/Florida Coastal Management Program consistency evaluation and is categorized as one of the following:

- ☐ Federal Assistance to State or Local Government (16 CFR 930, Subpart F). Agencies are required to evaluate the consistency of the activity.
- ☒ Direct Federal Activity (16 CFR 930, Subpart C). Federal Agencies are required to furnish a consistency determination for the State's concurrence or objection.
- ☐ Outer Continental Shelf Exploration, Development or Production Activities (16 CFR 930, Subpart E). Operators are required to provide a consistency certification for state concurrence/objection.
- ☐ Federal Licensing or Permitting Activity (16 CFR 930, Subpart D). Such projects will only be evaluated for consistency when there is not an analogous state license or permit.

FOR CONSISTENCY PROJECTS, SEE REVERSE SIDE FOR INSTRUCTIONS.

To: State Clearinghouse
Executive Office of the Governor -OPB
Room 1603, The Capitol
Tallahassee, FL 32399-0001
(904) 488-8114 (SC 278-8114)

Florida Coastal Management Program
Department of Community Affairs
Suite 305, Rhyme Building
2740 Centerview Drive
Tallahassee, FL 32399-2100
(904) 922-5438 (SC 292-5438)

EO. 12372/NEPA

Federal Consistency

- ☒ No Comment
- ☐ Comments Attached
- ☐ Not Applicable

- ☐ No Comment/Consistent
- ☐ Consistent/Comments Attached
- ☐ Inconsistent/Comments Attached
- ☐ Not Applicable

From:

Division/Bureau:

TRANSPORTATION

Reviewer:

James D. Kunkler

Date:

4/18/95



STATE OF FLORIDA
DEPARTMENT OF COMMUNITY AFFAIRS

2740 CENTERVIEW DRIVE • TALLAHASSEE, FLORIDA 32399-2100

LAWTON CHILES
Governor

LINDA LOOMIS SHELLEY
Secretary

March 14, 1995

Mr. Kenneth Kumor
NASA Headquarters
Code SL
300 E Street, Southwest
Washington, DC 20546-0001

RE: NASA Projects - Scoping Letter for Environmental
Assessment - Mars Global Surveyor (MGS) Spacecraft -
Cape Canaveral, Brevard County, Florida
SAI: FL9501270047C

Dear Mr. Kumor:

The Florida State Clearinghouse, pursuant to Presidential Executive Order 12372, Governor's Executive Order 93-194, the Coastal Zone Management Act, 16 U.S.C. §§1451-1464, as amended, and the National Environmental Policy Act, 42 U.S.C. §§ 4321, 4331-4335, 4341-4347, as amended, has coordinated a review of the above-referenced project.


The Department of Environmental Protection (DEP) recommends that the environmental assessment (EA) include an analysis of the potential impacts of the proposed spacecraft launch to the air, water, wetlands and wildlife resources in the project area. The EA should also include a federal consistency determination. Please refer to the enclosed DEP comments.

Based on the information contained in the scoping document and the enclosed comments provided by our reviewing agencies, the state has determined that, at this stage, the above-referenced project is consistent with the Florida Coastal Management Program (FCMP). All future environmental documents prepared for this project must be reviewed to determine the project's continued consistency with the FCMP. The state's continued concurrence

Mr. Kenneth Kumor
March 14, 1995
Page Two

with the project will be based, in part, on the adequate resolution of issues identified during this and subsequent reviews. Thank you for the opportunity to review this project.

Very truly yours,


for Linda Loomis Shelley
Secretary

LLS/rk

Enclosures

cc: Susan Goggin, Department of Environmental Protection
Margaret Spontak, St. Johns River Water Management District



Department of Environmental Protection

Lawton Chiles
Governor

Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

Virginia B. Wetherell
Secretary

28 February 1995

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MAR 1 1995

Florida Coastal
Management Program

Suzanne Traub-Metlay
State Clearinghouse
Office of Planning & Budgeting
Executive Office of the Governor
The Capitol
Tallahassee, Florida 32399-0001

RE: NASA/Scoping Letter for Launch of Mars Global Surveyor
(MGS) Spacecraft at Cape Canaveral, Brevard County
SAI: FL9501270047C

Dear Ms. Traub-Metlay:

The National Aeronautics and Space Administration (NASA) is preparing an Environmental Assessment (EA) to evaluate mission-specific environmental impacts associated with the launch of the Mars Global Surveyor spacecraft. Toward this end, NASA has requested our recommendations on issues to be included in the upcoming EA. We offer the following:

Since the proposed launch will occur at the Eastern Test Range at Cape Canaveral Air Station, impacts associated with new construction activities are not anticipated. The EA should therefore address potential impacts to the air, water, wetlands and wildlife due to the launch of the spacecraft. The EA should also include a federal consistency determination as required by the Coastal Zone Management Act. The purpose of the federal consistency review is to assure compliance with all the statutory provisions in the Florida Coastal Management Program.

We appreciate the opportunity to provide comments during the planning stages for the proposed launch. If I may be of further assistance, please feel free to call me at 487-2231.

Sincerely,

Susan Goggin
Environmental Specialist, MS 47
Office of Intergovernmental Programs

/s

"Protect, Conserve and Manage Florida's Environment and Natural Resources"

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WATER MANAGEMENT DISTRICT

Henry Dean, Executive Director
John R. Wehle, Assistant Executive Director
Charles T. Myers III, Deputy Assistant Executive Director

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February 28, 1995

Ms. Suzanne Traub-Metlay
Florida State Clearinghouse
Executive Office of the Governor - OPB
Room 1603, The Capitol
Tallahassee, FL 32399-0001

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MAR 6 1995

Florida Coastal
Management Program

Re: SAI # FL9501270047C
NASA Mars Global Surveyor (MGS)

Dear Ms. Traub-Metlay:

The staff of the St. Johns River Water Management District have reviewed the document listed above and have no comments at this time. We look forward to reviewing the Environmental Assessment when it is released in August, 1995. At that time we will review the project for consistency with our statutes and policies. Also, I noted that NASA listed G. Lowe in the distribution list for this District. Please notify NASA that all review documents should be sent to me.

If you have any questions or if I can be of further assistance, please contact me at (904) 329-4374.

Sincerely,

Margaret Spontak

Margaret Spontak, Director
Division of Policy and Planning

c: Florida Coastal Management

Patricia T. Harden, CHAIRMAN SANFORD	Lenore N. McCullagh, VICE CHAIRMAN ORANGE PARK	Jesse J. Parish, III, TREASURER TITUSVILLE	William Segal, SECRETARY MAITLAND
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			James H. Williams OCALA

COUNTY: BREVARD

DATE: 02/01/95

COMMENT DUE DATE: 02/16/95

SAI#: FL9501270047C

STATE AGENCIES

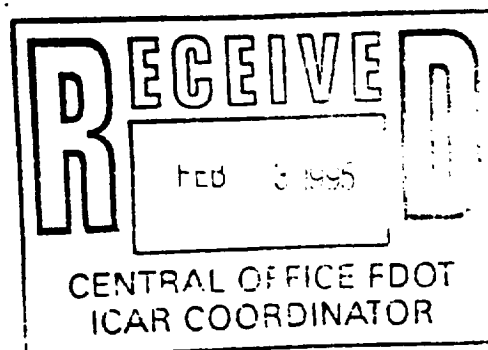
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OPB POLICY UNITS

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<input checked="" type="checkbox"/>	Game & Fish Comm
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<input type="checkbox"/>	Highway Safety
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<input type="checkbox"/>	Law Enforcement
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<input type="checkbox"/>	State Library
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<input type="checkbox"/>	DEP District

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<input type="checkbox"/>	Health & Human Srv
<input type="checkbox"/>	Revenue & Eco. Ana
<input type="checkbox"/>	SCH
<input checked="" type="checkbox"/>	SCH/CON



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Florida Coastal
Management Program

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Florida Coastal Management Director Department of Community Affairs Suite 305, Rhyne Building Tallahassee, FL. 32399-2100 (904) 922-5438 (SC 292-5438)	<input checked="" type="checkbox"/> No Comment <input type="checkbox"/> Comments Attached <input type="checkbox"/> Not Applicable	<input type="checkbox"/> No Comment/Consistent <input type="checkbox"/> Consistent/Comments Attached <input type="checkbox"/> Inconsistent/Comments Attached <input type="checkbox"/> Not Applicable

From:

Division/Bureau: TRANSPORTATION

Reviewer: James D. Kimbler JAMES D. KIMBLER, DISTRICT DIRECTOR OF PLANNING
AND PUBLIC TRANSPORTATION

Date: 2/15/95

